THE

DISSECTOR'S GUIDE:

BEING

A MANUAL FOR THE USE OF STUDENTS.

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BY

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PART I.

UPPER LIMB, LOWER LIMB, THORAX.

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MACLACHLAN AND STEWART.

LONDON: SIMPKIN, MARSHALL, AND CO.

1879.

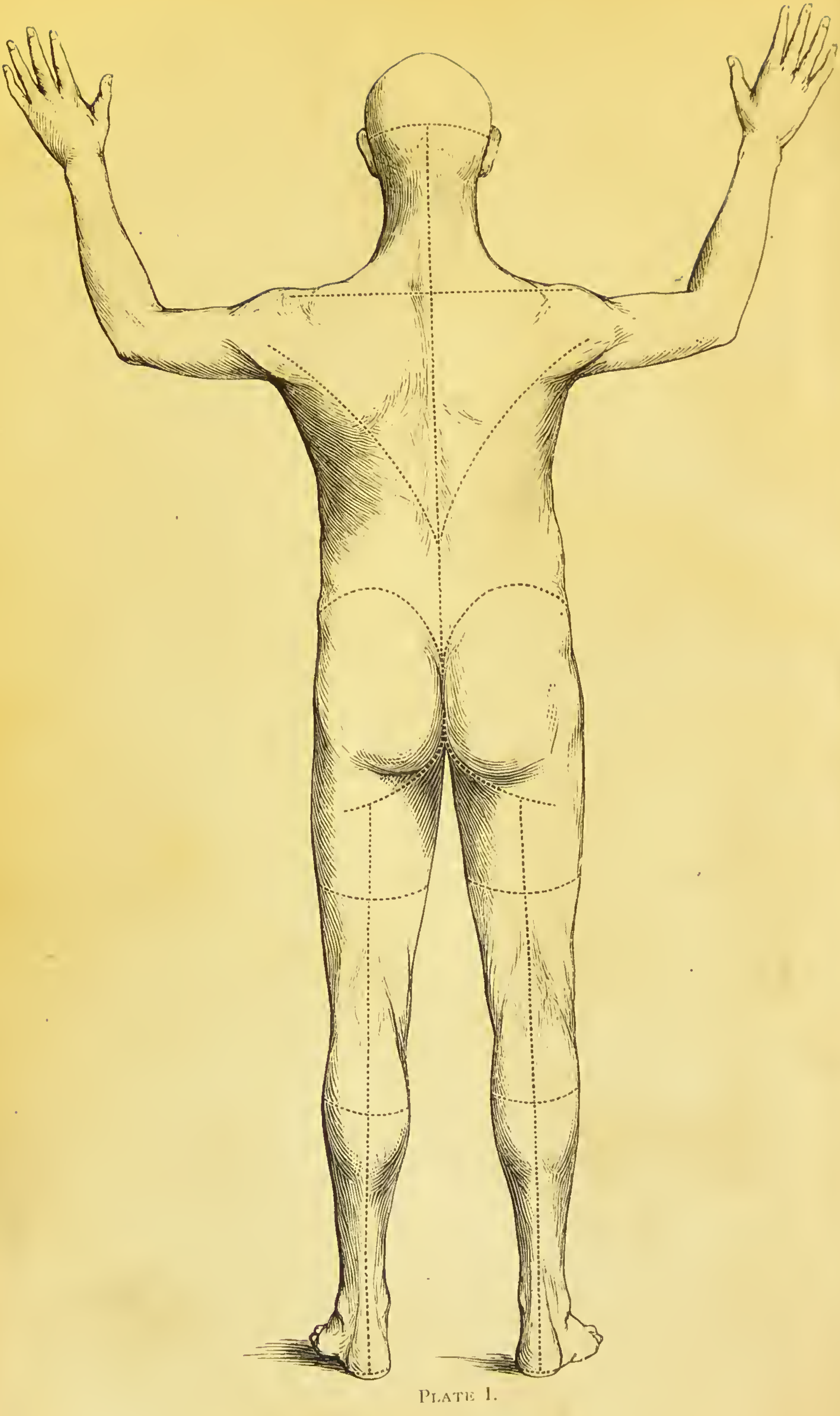


Plate I.

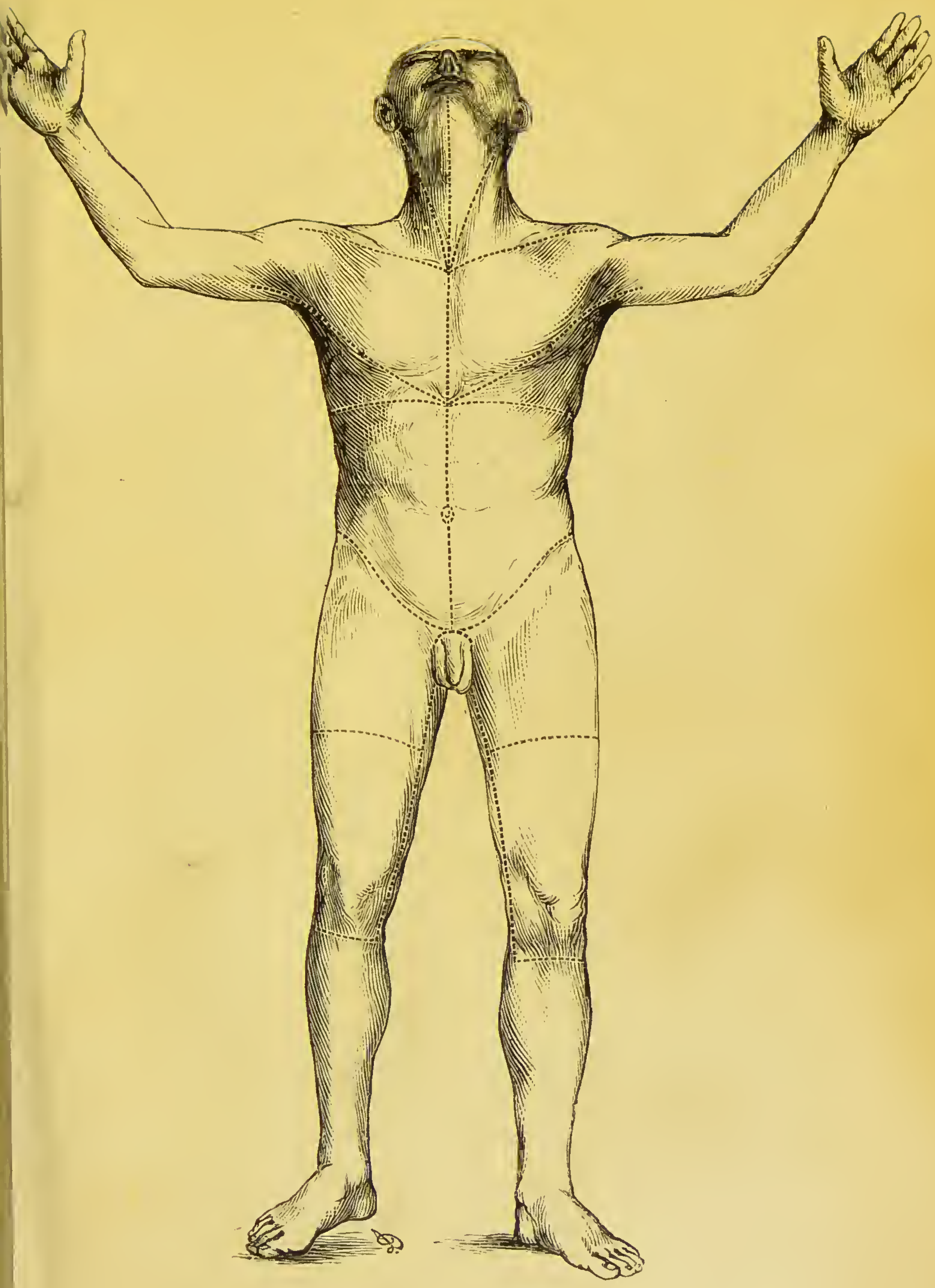


Plate II.

In certain of these structures the dissectors of the arm and head and neck have a joint interest. This dissection must be completed *in two days*, in order that the dissector of the head and neck may continue the deeper dissection of the back.

The *first day's work* should consist (*a.*) in the reflection of the skin, (*b.*) in the dissection of the cutaneous nerves and vessels, and (*c.*) in cleaning the latissimus dorsi and trapezius muscles. The remainder of the dissection can quite well be undertaken upon the *second day*.

Reflection of Skin.—*Incisions.*—(1.) From the tip of the coccyx upwards along the middle line of the body to the spine of the seventh cervical vertebra. (2.) From the upper end of this mesial incision transversely outwards to the inner border of the acromion process of the scapula. (3.) From the lower extremity of the mesial incision in a curved direction outwards along the crest of the ilium to within two or three inches of anterior superior iliac spine. (4.) An oblique incision from the spine of the first lumbar vertebra to the outer border of the acromion process (Pl. I. and Pl. III. p. 2).

By these incisions two large flaps of skin are mapped out upon the back. Reflect the upper triangular flap first, and then deal in the same way with the lower lumbar flap.

Cutaneous Vessels and Nerves.—Having studied the characters of the fatty superficial fascia, which lies subjacent to the skin, proceed with the dissection of

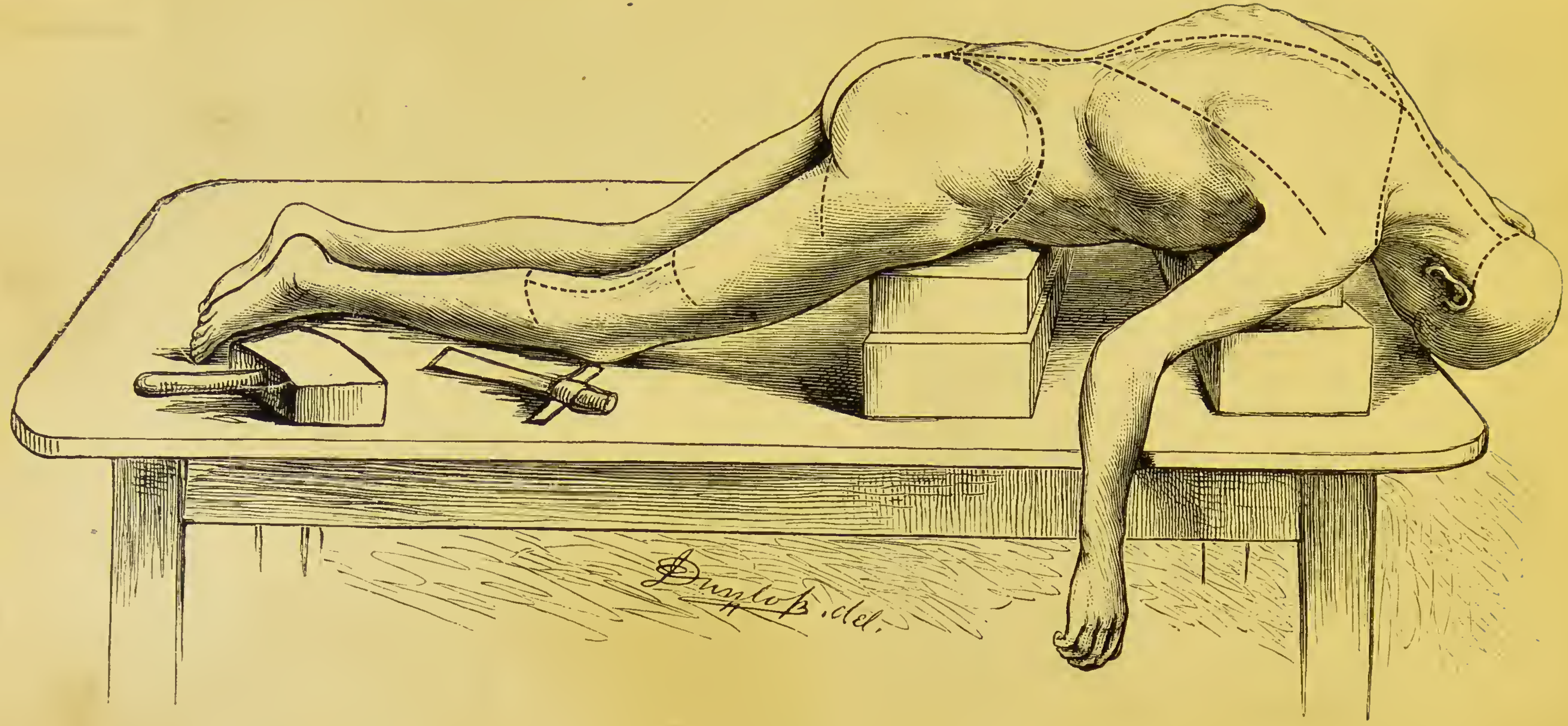


PLATE III.

the cutaneous vessels and nerves in the dorsal and lumbar regions. These are embedded in the substance of the superficial fascia.

In searching for a cutaneous nerve cut boldly down through the superficial fascia, in the direction in which the nerve runs, until you come to the plane at which the superficial and deep fasciæ blend. It is here that the main trunks are to be found, and in a well-injected subject the cutaneous vessels constitute the best guides.

A more rapid way of finding the cutaneous nerves in this region is to reflect both fasciæ outwards from the vertebral spines. The nerves are seen piercing the muscles. This plan, however, should only be adopted by the senior student.

The *upper six dorsal* cutaneous nerves spring from the internal branches of the posterior primary divisions of the spinal nerves. They become superficial close to the vertebral spines, and are to be sought for close to the middle line. The *lower six dorsal* cutaneous nerves and the *three lumbar* cutaneous nerves proceed from the external branches of the posterior divisions of the spinal nerves, and consequently they must be looked for at a short distance from the middle line of the back. They become superficial on a line with the angles of the ribs and the outer margin of the erector spinæ muscle.

Trapezius Muscle.—The trapezius should now be cleaned. This muscle belongs only in part to the dissector of the arm. That portion of it which lies above the level of the prominent spine of the seventh cervical vertebra is the property of the dissector of the head and neck, and must be cleaned by him. Let the two dissectors work in conjunction with each other, and, when the entire muscle is exposed, let each give the other an opportunity of studying it in its entirety.

In cleaning the trapezius the limb must be placed in such a position as will render the fibres of the muscle tense. Let us suppose that the dissection is to be made upon the right side of the body. In this case the arm must be placed close to the side, and drawn well downwards whilst the scapula is dragged forwards. A transverse cut is now to be made through the superficial and deep fasciæ from the spine of the seventh cervical vertebra outwards. This incision will be found to coincide with the direction of the fibres at this level. From this point gradually work downwards, raising both fasciæ in a continuous layer from the surface of the muscle. In doing this always keep the knife sweeping in the direction of the muscular fibres, and take care to leave none of the filmy deep fascia behind. If this rule be attended to, it will be found that as the dissection progresses the knife is not, as at first, being carried transversely but obliquely, in accordance with the direction of the fibres of the lower portion of the muscle. And now the position of the arm must be changed, in order that these oblique fibres may be placed on the stretch. The scapula must still be kept as far forward as possible, but the limb must be carried upwards and placed parallel with the neck.

In the case of the left trapezius the student must begin at the lower margin of the muscle and work upwards to the level of the seventh cervical vertebra. He will there be met by the dissector of the head and neck. The limb must in the first instance be extended and then placed by the side as the transverse fibres of the muscle are reached.

Latissimus Dorsi Muscle.—The same precautions are to be taken in clearing the fascia from the surface of the latissimus dorsi. The muscular fibres are fully stretched by raising the arm and folding it under the neck.

The latissimus dorsi is a difficult muscle to clean. Both layers of fascia should be raised together. As the muscle sweeps over the inferior angle of the scapula it usually receives a small accession of fibres from this bone. This fleshy slip may be brought into view by turning the upper margin of the muscle outwards. The origin of the latissimus dorsi from the lumbar spines is effected through the medium of the superficial or posterior lamina of the lumbar aponeurosis, a dense tendinous membrane which covers the erector spinæ muscle in the loins. Clean this thoroughly. The attachment of the muscle to the crest of the ilium and its three digitations from the three last ribs must be carefully defined.

You will now notice that a triangular space is mapped out by the latissimus dorsi, trapezius, and the base of the scapula. Within these limits a small portion of the rhomboideus major muscle will be seen, and also a varying amount of the chest wall—a portion corresponding to the sixth intercostal space.

On *the second day* the dissector should begin by reflecting the trapezius muscle.

Reflection of Trapezius.—This should be done, if possible, in conjunction with the dissector of the head and neck. Divide the muscle about half-an-inch from the spines of the vertebræ, and throw it outwards towards its insertion. In doing this, care must be taken not to injure the subjacent rhomboid muscles. The trapezius is very thin at its origin, and the rhomboids will not escape if the dissector be incautious. A small bursa between the tendon of insertion of the lower part of the trapezius and the root of the scapular spine must not be overlooked.

A dissection of the deep surface of the reflected muscle will reveal the following structures:—

(*a.*) Spinal accessory nerve.
(*b.*) Some nerves from the cervical plexus.
(*c.*) The superficial cervical artery.

These collectively constitute the nervous and vascular supply of the muscle.

The branches of the spinal accessory nerve and twigs from the third and fourth cervical nerves spread out upon the deep surface of the muscle, and join with each other so as to form a subtrapezial plexus. The terminal filaments of the former may, with care, be traced nearly to the lower border of the trapezius.

The superficial cervical artery must be followed upwards to the anterior border of the muscle, and here it will be seen to spring from the *transversalis colli.* The *posterior scapular* artery, which likewise proceeds from the transversalis colli, will then be seen to sink under cover of the levator anguli scapulæ.

Omo-hyoid—Suprascapular Artery and Nerve.—The posterior belly of the omo-hyoid and the suprascapular artery and nerve can now be displayed by dissecting towards the superior margin of the scapula. The dissector of the head and neck must take part in this dissection. Upon no account expose these structures for more than one inch from the upper margin of the scapula.

Rhomboids.—The rhomboideus major and minor should next engage the attention of the student. Draw the scapula well over the edge of the block which supports the chest of the subject. The fibres are thus rendered tense, and the cleaning of the muscles greatly facilitated. Note how the larger of the two muscles is usually inserted, in great part, into the base of the scapula, through the medium of a tendinous arch.

The Nerve to the Rhomboids can best be detected by dissecting in the cellular interval between the rhomboideus minor and the levator anguli scapulæ about one inch to the inside of the superior angle of the scapula; or it may be seen upon the deep surface of the muscles after they are reflected.

Levator Anguli Scapulæ.—In defining and cleaning this muscle care must be taken of the nerves which pass to it from the cervical plexus and also of the nerve to the rhomboids and the posterior scapular

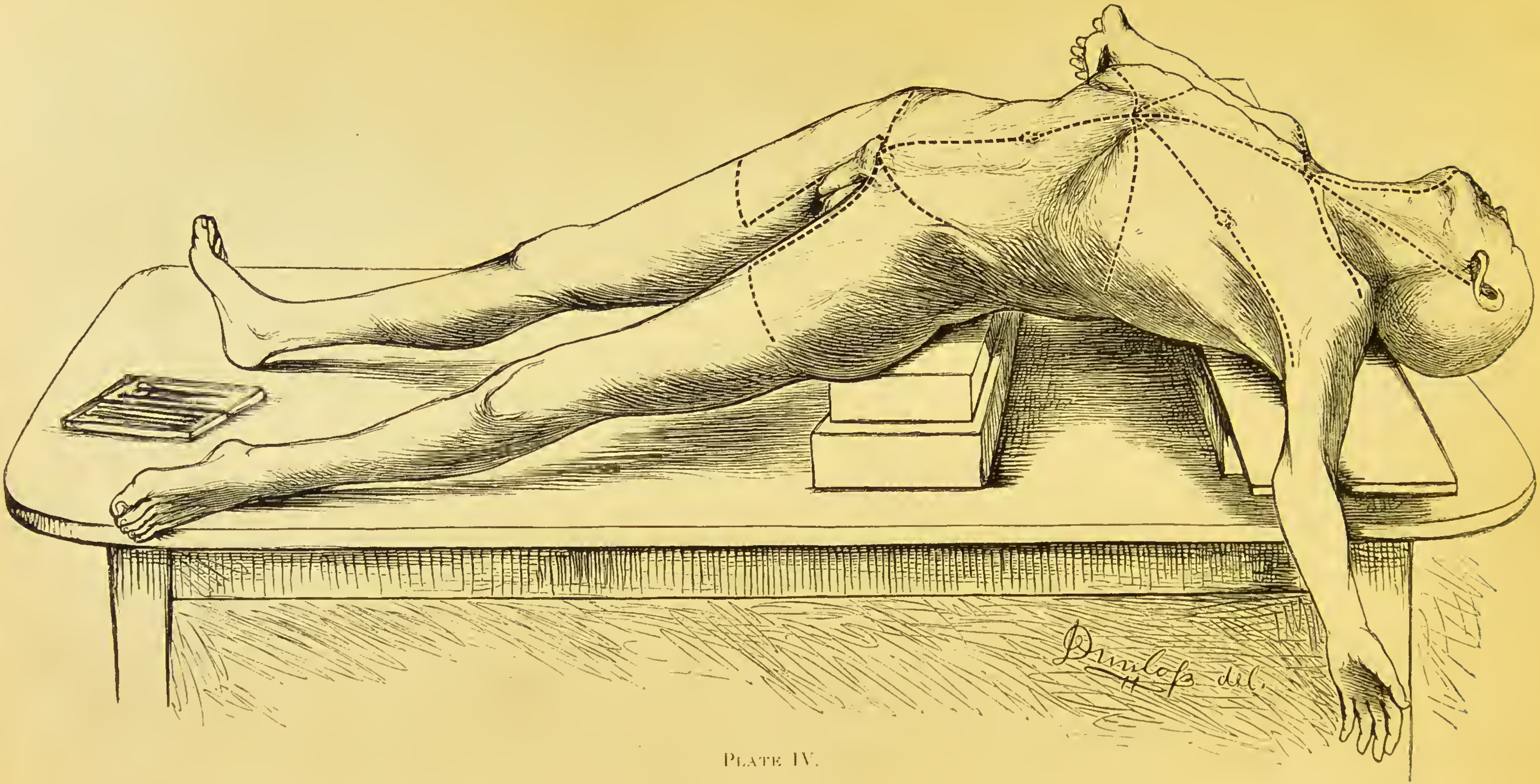


PLATE IV.

the deep surface of the muscle at the inferior angle of the scapula.

Lastly, replace the outer portion of the latissimus dorsi muscle and fix it in position by a stitch or two around one or more of the ribs. This is done so as to preserve the posterior fold of the axilla.

The dissector of the arm now stops work for two days. He has completed the dissection of all the dorsal structures which are allotted to him, and he has nothing further to do until the body is turned.

PECTORAL REGION AND AXILLARY SPACE.

On resuming work the dissector will find the body lying upon its back. The chest is raised to a convenient height by means of blocks. A long board is placed under the shoulders for the purpose of supporting the arms when they are abducted from the sides (Pl. IV.).

In dissecting the axilla and chest it will be found advantageous if the dissectors of the arm and head and neck arrange to work at different hours. The latter at this stage is engaged at the posterior triangle of the neck, and this dissection cannot be well done unless the arm be placed close to the side and the shoulder depressed. For the dissection of the axilla the arm should be stretched out at right angles to the chest. A compromise between these two positions always results in discomfort to both dissectors.

In the dissection of the pectoral region and the axillary space, the student meets with the following structures :—

(1.) Superficial fascia.
(2.) Cutaneous nerves.
(3.) Deep fascia—Axillary fascia.
(4.) Muscles which enter into the formation of the walls of the axilla.
  - Pectoralis major.
  - Pectoralis minor.
  - Subscapularis.
  - Teres major.
  - Latissimus dorsi.
  - Coraco-brachialis.
  - Serratus magnus.

(5.) Costo-coracoid membrane.
(6.) Cephalic vein.
(7.) Subclavius muscle.
(8.) Nerve to the subclavius.
(9.) Brachial plexus and certain of the branches which proceed from it.
(10.) Intercosto-humeral nerve.
(11.) The nerve of Bell.
(12.) The axillary vessels and their branches.
(13.) Lymphatic glands.

Four days are allowed for this dissection. The arm must then be removed so as to allow the dissector of the thorax to commence the dissection of the thoracic wall. The following Table may be found useful in regulating the amount of work which should be undertaken each day :—

First day.—(*a.*) Reflection of skin. (*b.*) Cutaneous nerves and vessels of the chest, both on its anterior and lateral aspects. (*c.*) Cleaning of the pectoralis major. (*d.*) Reflection of the axillary fascia. (*e.*) Cleaning of that part of the serratus magnus which lies below the fourth rib.

Second day.—Dissection of the axillary space from below. This includes the boundaries and contents of the space, in so far as they can be got at without the reflection of any muscle.

Third day.—(*a.*) Reflection of the clavicular origin of the pectoralis major. (*b.*) The costo-coracoid membrane and the structures piercing it. (*c.*) Removal of the membrane. (*d.*) The dissection of the upper part of the axilla. (*e.*) Reflection of the sternal origin of the pectoralis major.

Fourth day.—(*a.*) Reflection of pectoralis minor. (*b.*) General revision of the space and study of the axillary vessels and nerves. (*c.*) Removal of the middle third of clavicle. (*d.*) Separation of limb from the trunk.

PECTORAL REGION.

Reflection of Skin.—*Incisions.*—(1.) Along the middle line of the body from the upper margin of manubrium sterni to the tip of the ensiform cartilage. (2.) From the lower end of this vertical incision transversely outwards down the side of the body. (3.) From the upper extremity of the primary incision outwards along the clavicle to the extremity of the acromion process. (4.) From the lower end of the vertical and mesial incision (*i.e.*, tip of the ensiform cartilage) obliquely upwards and outwards along the anterior fold of the axilla to the point at which this joins the upper arm. This last incision may with advantage be carried vertically down the arm for two and a-half or three inches (Pl. II. and Pl. IV. p. 9).

Two triangular flaps of skin are marked out by these incisions, and these are now to be raised from the fatty superficial fascia. If the subject be a female it is well to encircle the areola and nipple with the knife and leave the skin covering them undisturbed.

Cutaneous Vessels and Nerves.—There are three distinct groups of cutaneous nerves, and each group has its own area of distribution. They are:—

(1.) The Anterior Cutaneous.
(2.) The Lateral Cutaneous.
(3.) The Descending Cutaneous.

The Anterior Cutaneous Nerves are minute terminal twigs of the intercostal nerves, and they become superficial close to the margin of the sternum. One is found in each intercostal space, and they are accompanied by the *perforating branches* of the internal mammary artery. *The Lateral Cutaneous Nerves* are the lateral branches of the intercostal nerves. They are found upon the side of the chest between the digitations of the serratus magnus. Trace the anterior and posterior branches of these, forwards over the lower margin of the pectoralis major and backwards over the anterior margin of the latissimus dorsi. Do not attempt to secure the two highest lateral cutaneous nerves (*i.e.*, those issuing from the second and third intercostal spaces) in the meantime. They are best dissected along with the other contents of the axillary space. *The Descending Nerves* come from the cervical plexus, and are found passing downwards over the clavicle. Whilst searching for these the dissector cannot fail to observe the sparse fibres of the platysma myoides arising from the pectoral fascia.

Mammary Gland.—Examine next the mammary gland, and make out its precise extent and connections by removing the fatty superficial fascia around it. Carefully reflect the skin, which has been left, towards the summit of the nipple, and inserting bristles through the minute external orifices, try to make out the milk ducts and their ampullæ or sacculations.

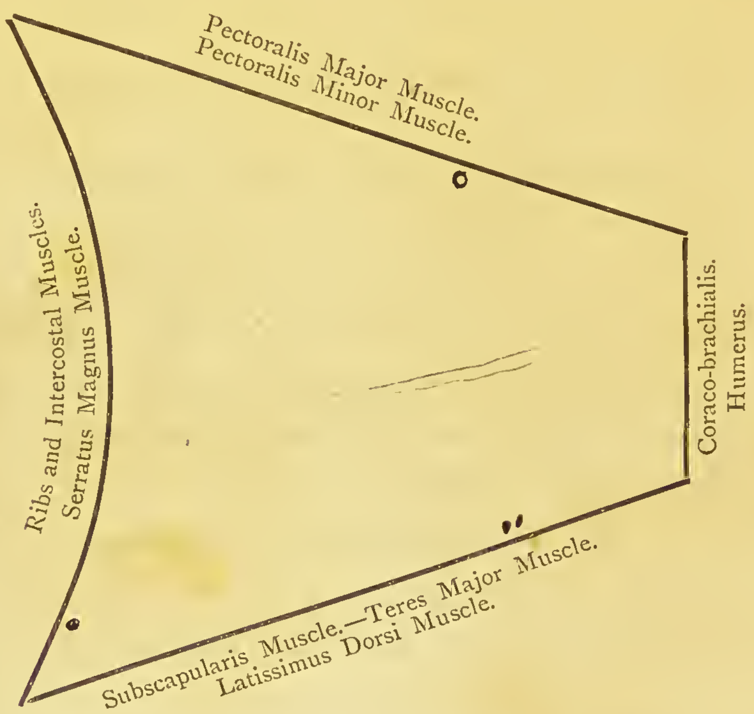
Pectoralis Major.—This muscle must now be cleaned and its division into sternal and clavicular parts clearly made out. The muscular fibres are rendered tense by abducting the arm from the side. On the right side of the body the dissector begins at the lower margin of the muscle, whilst on the left side he commences at the upper border. Clean also the anterior margin of the deltoid. In the cellular interval between it and the clavicular pectoralis major the *cephalic vein* and the *humeral-thoracic* artery will be discovered.

Axillary Fascia.—In removing the deep fascia from the surface of the pectoralis major notice how it is continuous around the lower margin of the muscle with the axillary fascia. Continue the dissection so as to raise the axillary fascia in one piece. In a well-injected subject a small artery from the lower part of the axillary may be observed ramifying upon, and ultimately piercing the fascia, as it stretches between the two folds of the axilla.

AXILLA OR ARMPIT.

Dissection from Below.

The axillary fascia having been removed, and the boundaries of the axilla, in consequence, to a certain extent displayed, the contents of the space should



be dissected from below by the cautious removal of the loose areolar tissue and fat in which they are embedded. In doing this numerous lymphatic glands will be exhibited, and these may also be removed as they come into view.

Begin by dissecting out the *subscapular* artery and the *long subscapular* nerve as they traverse the posterior wall. The guide to their position is the lower margin of the subscapularis muscle. Lying against the anterior wall, and in relation to the lower margin of pectoralis minor, the *long thoracic* artery will be found. A vertical incision along the inner wall, a short distance anterior to the point at which this joins the posterior wall, will display the *external respiratory* nerve, or the *nerve of Bell*, upon the axillary surface of the serratus magnus. Next by carrying the knife obliquely through the loose tissue, from the inner to the outer wall, the *lateral cutaneous* branch of the *third intercostal* nerve and the *intercosto-humeral* branch of the *second intercostal* nerve will be found.

These structures being secured, the dissector may proceed with his work more boldly, as the other contents of the space are not so liable to injury. Trace the branch from the third intercostal nerve and the intercosto-humeral to their distribution on the inner aspect of the upper arm, and make out the junction between the latter and the nerve of Wrisberg. This will naturally lead the student to examine the important structures which lie in relation to the outer wall of the space—viz., the *axillary artery and vein* and the *axillary nerves.* In the first place note the close manner in which these cling to the outer wall of the axilla in the various movements of the limb, and then proceed to isolate them and establish their individual identity. In dissecting these structures care must be taken of the *internal cutaneous* branch of the *musculo-spiral* nerve.

Axillary Vessels.—It is the third part of the axillary artery that is now exposed. Observe that this is not covered by any muscular structure in its lower part. It will be seen that this is due to the posterior wall of the axilla extending further downwards than the anterior wall. The axillary vein lies to inner side of artery. Three branches are given off by this portion of the artery, but only two of them can be examined in the present stage of the dissection—viz., the *subscapular* and the *posterior circumflex* arteries. The *anterior circumflex* will be studied when the pectoralis major is reflected.

Axillary Nerves.—These lie grouped around the artery. To its outer side is the *musculo-cutaneous*, which soon leaves it, however, to pierce the substance of the coraco-brachialis muscle. Embracing the artery are the two heads of the *median* nerve, which at first lies upon and then to the outer side of the vessel. To its inner side are the *ulnar*, *internal cutaneous*, and *lesser internal cutaneous* nerves. The last of these we have already seen effecting a communication with the intercosto-humeral nerve. Behind the axillary artery are the *circumflex nerve* and the large *musculo-spiral* nerve. The latter whilst still within the axilla gives off its *internal cutaneous* nerve, and this must not be overlooked in the dissection. In the last place, the *middle subscapular* nerve must be looked for. It will be found on the surface of the

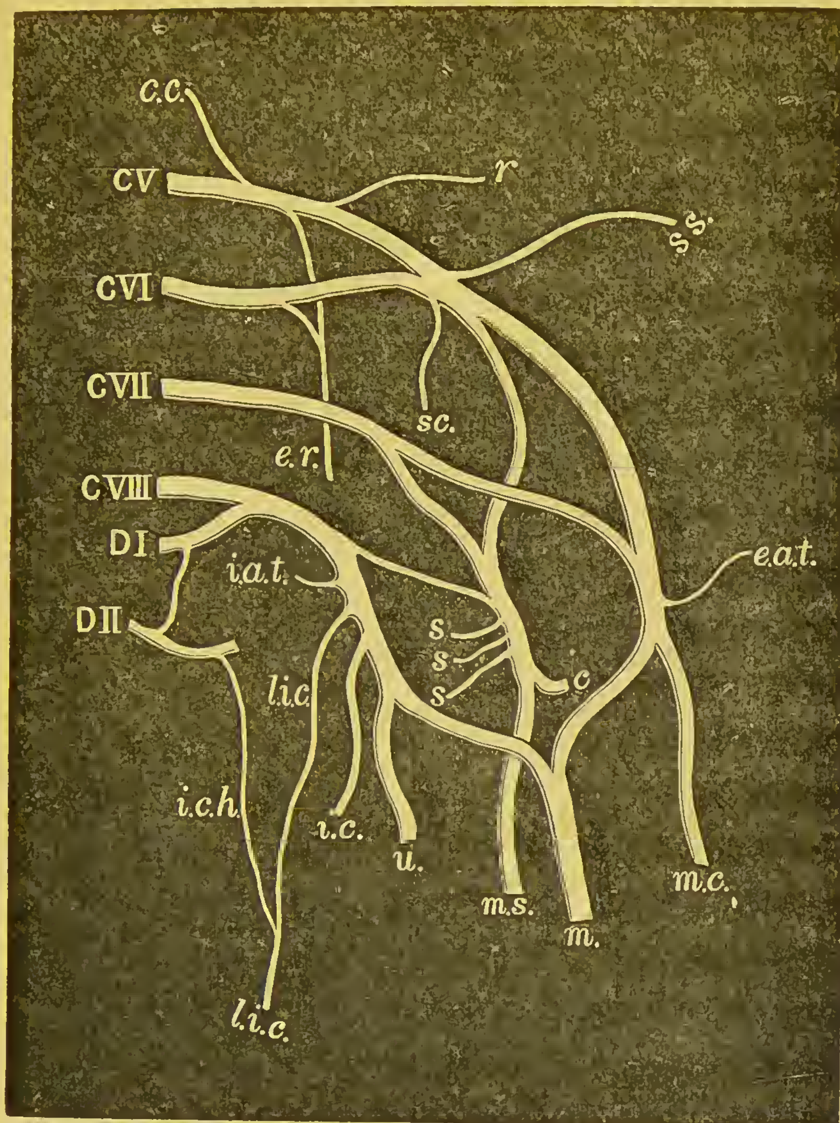


FIG. 1.

Diagram of the brachial plexus. C V, C VI, C VII, C VIII, The four anterior primary divisions of the cervical spinal nerves which take part in its formation ; D I and D II, The anterior primary divisions of the first two dorsal nerves ; *c.c.*, Communicating twig from the fourth cervical nerve ; *r.*, Nerve to rhomboids ; *s s.*, suprascapular nerve ; *s c.*, Nerve to subclavius ; *e.r.*, External respiratory nerve, or nerve of Bell ; *e.a.t.*, External anterior thoracic nerve ; *m.c.*, Musculo-cutaneous nerve ; *m.*, Median nerve ; *i.a.t.*, Internal anterior thoracic nerve ; *l.i.c.*, Lesser internal cutaneous nerve, or the nerve of Wrisberg ; *i.c.h.*, Intercosto-humeral nerve ; *i.c.*, Internal cutaneous nerve ; *u.*, Ulnar nerve ; *s, s, s*, The three subscapular nerves ; *c.*, Circumflex nerve ; *m.s.*, Musculo-spiral nerve.

subscapular muscle giving twigs both to it and the teres major.

Dissection of Axilla from the Front.

The axillary space must now be dissected from the front. This is done by reflecting the clavicular part of the pectoralis major. The sternal portion of the muscle is upon no account to be disturbed. Divide the clavicular part close to its origin from the clavicle, and throw it downwards and outwards. This must be done with care, because some twigs from the *external anterior thoracic* nerve, and also some of the *pectoral thoracic* branches of the thoracic axis artery, enter its deep surface. All these must be thoroughly cleaned and preserved.

Costo-Coracoid Membrane.—A space or gap bounded by the clavicle, pectoralis minor, pectoralis major, and coracoid process is now exposed. This gap, however, is closed by the costo-coracoid membrane, the connections of which must be studied. Trace it outwards to its coracoid attachment, and inwards to its costal attachment. Above it constitutes the sheath of the subclavius muscle by splitting into an anterior and a posterior layer. These passing upwards enclose the muscle and are attached, the one to the anterior border of the clavicle, and the other to the posterior border of the bone. But how can the two layers be demonstrated? Divide the anterior layer transversely close to the clavicle, and throwing it downwards, pass the handle of the scalpel upwards behind the muscle. The posterior attachment can in this manner be verified, and at the same time the nerve to the subclavius will be seen sinking into the deep surface of the muscle. Observe how the density of the membrane diminishes almost immediately below the subclavius, and this so abruptly that a crescentic margin is formed. Its lower connections

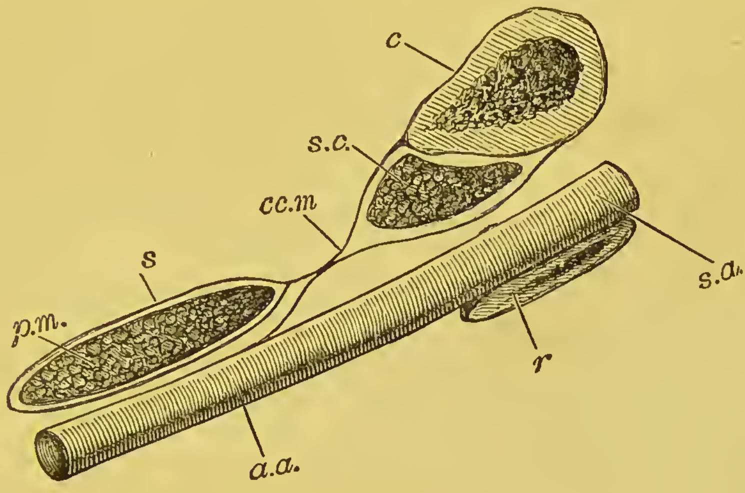


FIG. 2.

Diagram to show the upper and lower attachments of the costo-coracoid membrane Section through the clavicle, &c., in the line of the axillary artery.

c, Clavicle.
r, First rib.
s.a., Subclavian artery.
a.a., Axillary artery.
s.c., Subclavius muscle.
cc.m, Costo-coracoid membrane.
s., Sheath of pectoralis minor.
p.m., Pectoralis minor muscle.

are somewhat indefinite and difficult to establish with precision. In a good subject, however, it will be seen to join the sheath of the axillary vessels, and also to give a process of fascia to the sheath of the pectoralis minor.

Four structures pierce the costo-coracoid membrane and these must be noted. They are: (1.) The thoracic axis artery—breaking up into (*a*) pectoral thoracic, (*b*) clavicular thoracic, (*c*) acromial thoracic, (*d*) humeral thoracic branches; (2.) The thoracic axis vein; (3.) The cephalic vein; and lastly (4.) The external anterior thoracic nerve.

Now remove the costo-coracoid membrane. The upper part of the axillary space is opened into, and the contents with a little dissection may be exposed. The *axillary artery* is the most important object. Lying to its inner side will be seen the *axillary vein*, and above and external to it *three large brachial nerves*. Crossing behind the artery is the *external respiratory* nerve. The *thoracic axis* artery will be seen to be a branch of this part of the axillary trunk, and a second branch, the *superior thoracic*, may be followed out. Lastly, the *cephalic vein* must be traced to its junction with the axillary vein.

Reflection of the Sternal Portion of the Pectoralis Major.—This constitutes the next step in the dissection. Divide the muscle about its middle and throw the two parts outwards and inwards. Twigs from both the *external anterior thoracic* and the *internal anterior thoracic* nerves will be observed to enter the muscle. The latter, to reach their destination, pierce the pectoralis minor.

Reflection of the Pectoralis Minor.—This is effected by cutting the muscle midway between its origin and insertion. Trace now the *internal* and *external anterior thoracic* nerves to their origin from the inner and outer cords of the brachial plexus. The *upper subscapular* nerve sinking into the upper part of the subscapularis muscle can now be displayed.

Section of the Clavicle.—The dissector of the head and neck must help in this dissection. It simply consists in reflecting the subclavius muscle and removing the middle third of the clavicle by means of the saw and bone pliers. This is done so that both dissectors may obtain a connected view of the structures which pass from the side of the neck into the axilla.

Removal of the Arm from the Body.—The upper limb may now be removed from the trunk. Tie the axillary vessels and nerves together in a bunch at two points a short distance from each other and at the level of the clavicle, and then divide them between the ligatures. Now draw the arm forcibly from the side and cut through the latissimus dorsi, serratus magnus,* levator anguli scapulæ (if it has not been previously divided), and omo-hyoid muscles, and also the suprascapular artery and nerve, and the nerves and vessels which go to the deep surface of the trapezius. The arm will then be found to be free, and it should be carried to one of the tables which are reserved for the dissection of separate parts.

SHOULDER—SCAPULAR REGION.

This dissection comprises the following parts :—

(1.) Cutaneous nerves of the shoulder.
(2.) Deltoid muscle.
(3.) Subacromial bursa.
(4.) Anterior and posterior circumflex arteries.
(5.) Circumflex nerve.
(6.) Dorsalis scapulæ artery.
(7.) Subscapularis muscle.

* As this is the best time to study the serratus magnus, the dissector should examine it thoroughly before dividing it.

(8.) Supraspinatus, infraspinatus, teres minor, and teres major muscles.
(9.) Bursæ in connection with the shoulder-joint.
(10.) Suprascapular nerve and artery.

The divided ends of muscles should in the first place engage the attention of the student. Let him define the precise insertions of the trapezius, omohyoid, levator anguli scapulæ, the rhomboids, and the serratus magnus, and then remove what is left of those muscles with the exception of half-an-inch close to the bone.

Cutaneous Nerves—Deltoid Muscle.—Place a block in the axilla, and reflect the skin from before backwards over the deltoid muscle. In the superficial fascia, which is thus laid bare, cutaneous nerves from two sources will be found: (*a*) a few slender twigs which are prolonged downwards over the acromion process. These are the *descending branches* of the cervical plexus, and they ramify over the upper third of the deltoid, (*b*) the *cutaneous branch* of the *circumflex* nerve. The former are somewhat difficult to find, seeing that the main trunks have been divided in the removal of the arm, but the branch from the circumflex is a large nerve and must in no case be overlooked. It becomes superficial at the posterior margin of the deltoid about two or three inches above its insertion, and here it is most readily found. After these nerves have been followed out and their area of distribution determined, the deltoid muscle should be cleaned. Depress the scapula, and retain it in this position by means of hooks. The fibres of the muscle are in this way kept tense.

Circumflex Vessels and Nerve.—The limb should now be placed upon its posterior aspect and the posterior circumflex artery, and the circumflex nerve traced backwards through the *quadrilateral space*—defining at the same time the boundaries of the space. *The dorsalis scapulæ artery* may also be followed into the *triangular space* to the point at which it disappears around the axillary margin of the scapula under cover of the teres minor.

Reflection of the Deltoid.—This constitutes the next step in the dissection. Divide the muscle close to its origin from the clavicle, acromion process, and spine of the scapula, and throw it downwards. An equally good way of reflecting this muscle is to detach it from its insertion and throw it upwards. A large *bursa* situated between the deltoid and the superior part of the capsule of the shoulder-joint will now come into view. This should be opened and its extent explored by introducing the finger into its interior. It will be found not merely to intervene between the deltoid and the capsular ligament, but also to extend between the coraco-acromial arch and the ligament. In the latter position it goes under the title of the *sub-acromial bursa.* The ramifications of the *posterior circumflex* artery and the *circumflex* nerve upon the deep surface of the deltoid can now be dissected out. The branch of the latter to the *teres minor* and the ganglionic swelling upon it are seen, and the quadrilateral space is brought strikingly under the notice of the student. Lastly, trace the *anterior circumflex* artery outwards as it passes under cover of the short head of biceps and coraco-brachialis muscles. Note how it ends by dividing at the bicipital groove into two branches.

Scapular Muscles.—The supraspinatus, infraspinatus, and teres minor on the dorsum scapulæ, and the subscapularis on the venter scapulæ must now be examined. The acromion process should be divided with the saw close to its junction with the spine of the scapula, in order that an uninterrupted view of the supraspinatus may be obtained. Reflect these muscles by dividing them at their middle, and dissect the outer portions outwards, so as to display the close connection of these muscles with the capsule of the shoulder-joint. In doing this take care of the *suprascapular* artery and nerve and the *dorsalis scapulæ* artery on the dorsum of the scapula. In the case of the subscapularis, and perhaps also in the case of the infraspinatus, a bursa will be found intervening between the muscle and the capsule of the joint. Open these with the knife and introduce the tip of the finger. The finger will pass directly into the cavity of the joint, demonstrating the fact that these bursæ are merely hernial protrusions of the synovial membrane.

The Suprascapular Artery and Nerve.—These have already been partially exposed on the dorsum scapulæ, and they must now be cleaned, and their branches followed out. A very complete anastomosis around the bone may be made out. The posterior scapular artery in connection with the base or vertebral border of the scapula, the suprascapular artery in connection with the superior margin of the bone, and the subscapular and dorsalis scapulæ in connection with the axillary border, all take part in this inosculation. In addition to some branches to the venter scapulæ, the dorsalis scapulæ artery will be found to give off a very constant branch, which runs down to the inferior angle of the bone between the origins of the teres major and teres minor muscles.

Teres Major Muscle.—The part which this muscle plays in the formation of the quadrilateral and triangular spaces has already been seen. It only remains for the student to examine its origin and insertion.

Lastly, remove the fleshy portions of the subscapularis, supraspinatus, infraspinatus, and teres minor muscles, leaving only a small part of each, close to their insertions, in order that they may again be examined in their relation to the shoulder-joint.

FRONT OF THE UPPER ARM.

In this dissection the following parts have to be studied :—

(1.) Cutaneous vessels and nerves.
(2.) Brachial aponeurosis.
(3.) Brachial artery and its branches.
(4.) Median, ulnar, musculo-spiral and musculo-cutaneous nerves, and the branches of the two last.
(5.) Biceps, coraco-brachialis, and brachialis anticus muscles.

In conjunction with this dissection it is also convenient to study the triangular space in front of the elbow-joint and its contents.

Reflection of Skin.—Two incisions are required: (1.) A vertical incision along the middle of the projection formed by the biceps to a point fully three inches below the bend of the elbow. (2.) A transverse cut at right angles to the lower extremity of this, extending right across the forearm. Now raise the two flaps of skin and throw them outwards and inwards.

Cutaneous Nerves.—The *internal cutaneous* branch of the *musculo-spiral*, the nerve of *Wrisberg*, and the twigs from *third intercostal* nerve and *intercosto-humeral*, are all to be traced to their terminations upon the inner aspect of the arm. The *internal cutaneous nerve* will be found piercing the deep fascia, to become superficial, about the middle of the arm on its inner aspect. Following this downwards, it will be found to divide into an *anterior* and *posterior* branch. The former passes down in front of the internal condyle, whilst the latter is directed down behind it.

On the outer aspect of the arm secure the *external cutaneous* branch of the *musculo-spiral* and the *cutaneous portion* of the *musculo-cutaneous*. The former will be found a short distance below the insertion of the deltoid, and the margin of the external intermuscular septum is the best guide to it. It usually is in the form of two nerves, which become superficial at different levels—the one a little lower down than the other.

The cutaneous part of the musculo-cutaneous nerve pierces the fascia close to the outer side of the tendon of the biceps, and it can very readily be found at this point.

Superficial Veins.—Observe the arrangement of the superficial veins at the bend of the elbow. The *anterior* and *posterior ulnar veins* will be found on the inner side of the forearm, the *radial vein* on the outer side, and the *median* joined by the *profunda vein* in the middle line of the forearm. The median divides into two diverging branches—viz., the *median basilic* directed upwards and inwards over the bicipital fascia, and the *median cephalic* passing upwards and outwards. The anterior and posterior ulnar veins may now be traced to their junction with the median basilic, and the resultant vein—*the basilic*—can be followed upwards to the middle of the arm, where it usually disappears by piercing the deep fascia. The radial vein joins the median cephalic to form the *cephalic vein*, and this may be followed up the outer aspect of the arm.

Deep Fascia.—The brachial aponeurosis is in the next place to be cleaned by the removal of the superficial fatty layer, and its attachment to the bony points of the elbow made out. Notice how it is connected with the tendons of the deltoid, pectoralis major, &c., and more especially the accession of fibres it acquires at the bend of the elbow from the tendon of the biceps. These fibres constitute the *bicipital* or *semi lunar* fascia, and bridging over the brachial artery, they are lost over the pronator radii teres muscle on the inner side of the forearm. The deep fascia may be reflected by making an incision through it along the middle line of the arm. In throwing the inner portion inwards, the dissector must leave the bicipital fascia in position. This may be done by separating it artificially from the general aponeurosis by an incision above and below it. It will be afterwards seen to intervene between the median basilic vein and the

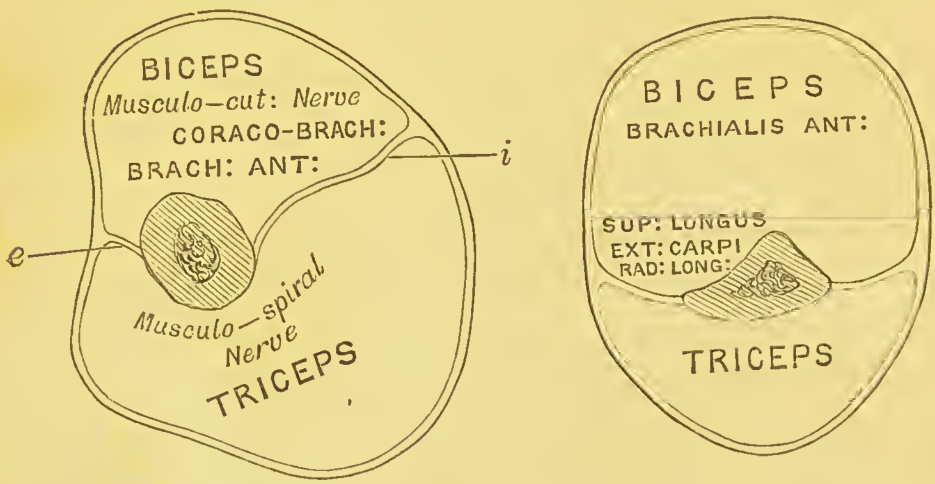


FIG. 3. FIG. 4.

Diagrams (after Prof. Turner) to show how the upper arm is divided by the intermuscular septa into an anterior and posterior compartment. These compartments are represented in transverse section. Fig. 3 represents a section a short way above the middle of the forearm, and certain of the contents of the compartments at this level are indicated. *e*, External intermuscular septum; *i*, Internal intermuscular septum. It is a mistake to suppose that the septa do not reach higher up the limb than the insertion of the coraco-brachialis. In Fig. 4 the section is made a short distance above the elbow-joint.

brachial artery. The position and extent of the *external* and *internal intermuscular* septa of the arm can now be seen, and the dissector should note how they divide the upper arm into an anterior and posterior osteo-fascial compartment.

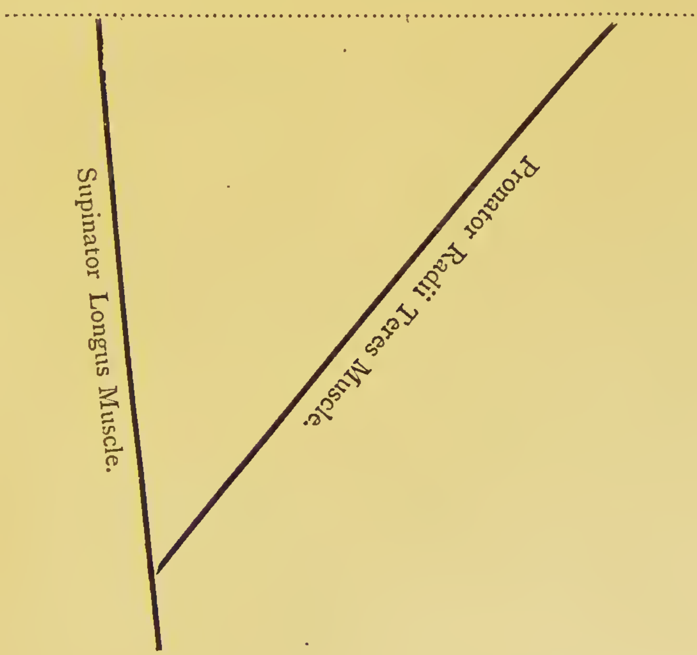
Brachial Artery—Nerves of Upper Arm.—Before the muscles are disturbed the brachial artery and its branches should be followed out. The venæ comites, which lie one on either side of the vessel, render this dissection somewhat tedious. A short distance below the bend of the elbow the artery ends by dividing into the *radial* and *ulnar* arteries. With the exception of the musculo-cutaneous, all the nerves of the arm will be seen to lie for a certain part of their course in relation to the vessel. The *median* nerve lies at first along its outer side; at the middle of the arm it crosses the artery, and then it continues down upon its inner side. The *ulnar* and *internal cutaneous* lie close to its inner side, as far as the insertion of the coraco-brachialis, and they then leave the artery. The former inclines backwards, and piercing the internal intermuscular septum, it enters the posterior compartment of the arm. The internal cutaneous nerve, on the other hand, inclines forwards, and piercing the deep fascia, becomes superficial. The *musculo-spiral* lies for a short distance behind the brachial artery, but it soon leaves it, and passes backwards and downwards between the outer and inner heads of the triceps. Do not trace it further at present. The median and ulnar nerves give off no branches in the upper arm.

Now clean the branches of the brachial artery. From the outer side of the vessel spring the *muscular twigs;* from the inner side the *superior profunda*, the *inferior profunda*, the *nutrient*, and the *anastomotica magna* proceed. *The superior profunda* arises close to the lower border of the teres major muscle, and accompanies the musculo-spiral nerve. *The inferior profunda* comes off a little lower down and following the course of the ulnar nerve, it sinks through the internal intermuscular septum. *The nutrient* artery seldom springs directly from the brachial. It is more usual for it to arise from the inferior profunda. *The anastomotica magna* will be found passing inwards over the brachialis anticus, immediately above the elbow. Some of its branches proceed down in front of the internal condyle, whilst others pass backwards through the internal intermuscular septum.

Muscles and Musculo-cutaneous Nerve.—The muscles in relation to the brachial artery—viz., the biceps, coraco-brachialis, and brachialis anticus—should now be carefully cleaned and their attachments made out, and in connection with them the musculo-cutaneous nerve may be followed downwards. As it pierces the coraco-brachialis muscle it supplies it with twigs, and as it lies between the biceps and brachialis anticus it gives branches to both.

Lastly, separate the supinator longus muscle from the brachialis anticus, and dissect out the *musculo-spiral* nerve and the *superior profunda* artery, which lie deeply between them. Here also the anastomosis between the superior profunda and the radial recurrent arteries may be made out in a well-injected subject, and the twigs from the musculo-spiral to the brachialis anticus, supinator longus, and extensor carpi radialis longior looked for.

Triangular Space in Front of Elbow.—In dissecting an anatomical space it is important that the student should follow a definite plan. In every case begin by determining the *coverings* of the space, or those structures which have been removed so as to bring it into view. Then dissect out the *boundaries.* In doing this, however, the muscles should never be disturbed in their position, and therefore the bounding margins of the muscles alone should be cleaned. *The contents* of the space should next engage the attention of the dissector ; and lastly, the parts which enter into the formation of *the floor.*



Follow this method in your examination of the space in front of the elbow-joint. The supinator longus bounds it on the outer side, the pronator teres on the inner side, and the base is formed by a line drawn between the condyles of the humerus ; the brachial artery and its two terminal branches, the median nerve, and the tendon of the biceps are the contents ; the brachialis anticus and the supinator brevis constitute the floor.

When the bounding muscles are separated widely from each other, other structures come into view, but they cannot be regarded as lying within the space proper. They are—(1.) The musculo-spiral nerve, and the superior profunda and radial recurrent arteries lying deeply between the supinator longus and the brachialis anticus ; (2.) The anterior ulnar recurrent and some branches of the anastomotica magna, placed under cover of the pronator radii teres.

BACK OF UPPER ARM.

This dissection includes :—

(1.) The triceps muscle.
(2.) Superior profunda artery and the musculo-spiral nerve.
(3.) The inferior profunda artery and ulnar nerve.
(4.) Posterior branches of the anastomotic artery.
(5.) Subanconeus muscle.
(6.) Anconeus muscle.

Reflection of Skin.—No additional incision is necessary. Remove the skin from the entire upper arm and for three inches below the elbow-joint. As the integument is being raised from the olecranon, a synovial bursa will be found intervening between the bone and the deep fascia.

Triceps Muscle.—To place this muscle on the stretch the scapula must be extended, and the forearm flexed at the elbow-joint. The three heads can now be cleaned and isolated from each other. Observe how the musculo-spiral nerve and superior profunda artery disappear from view between the inner and outer heads. By thrusting the little finger or the handle of the scalpel along the musculo-spiral groove on the back of the humerus, the strong tendinous fibres which bridge over the groove and protect the nerve and artery may be demonstrated. These fibres are derived from the external head of the muscle. Now divide the external head and expose the musculo-spiral groove. It will be seen that no fibres arise from this. The external head arises above and external to it, and the internal head takes origin below and internal to it. But further, the musculo-spiral nerve will be observed to pass forwards through the external intermuscular septum, and the superior profunda artery to divide into two branches, of which one accompanies the nerve and passes down in relation to the anterior surface of the intermuscular septum, whilst the other continues its course behind the intermuscular septum. The branches of the musculo-spiral nerve to the triceps muscle must be cleaned. A long slender branch which passes downwards, and which seems to end in the triceps, may be followed downwards to the anconeus muscle. The external cutaneous branches will be seen arising close to the external intermuscular septum. The ulnar nerve and the inferior profunda and anastomotic arteries must be traced in their course downwards towards the interval between the olecranon and internal condyle. They lie upon the dorsal aspect of the internal intermuscular septum, and have a thin covering of the fibres of the internal head of triceps.

To find the small *subanconeus* muscle the triceps must be divided transversely a short distance above the elbow-joint, and in making the dissection a communicating branch which passes across the back of the humerus from the anastomotica magna to the superior profunda artery will be discovered. The bursa between the tendon of the triceps and the olecranon must not be overlooked.

Anconeus Muscle.—This muscle, although it is situated in the forearm, should be studied at this stage. It is simply a part of the triceps muscle—a continuation downwards of it. The nerve to this muscle from the musculo-spiral has already been noted.

FOREARM.

The skin should be removed from the forearm both on its anterior and posterior aspects. It is well also to remove the integument from the dorsum of the hand at the same time. The skin should be kept so that it may be restored to its position after each day's dissection.

Reflection of Skin.—*Incisions.*—(1.) A vertical incision along the middle line of the forearm on its anterior aspect to a point about one inch below the radio-carpal joint. (2.) A transverse incision at right angles to the lower end of the mesial cut from the radial to the ulnar margins of the wrist; this incision should be carried well round the wrist so as to end on the dorsal aspect of the hand. (3.) Lastly, an incision from each extremity of the latter along the radial and ulnar margins of the hand.

Superficial Veins. — The four superficial veins which we have previously seen entering into the formation of the cephalic and basilic veins must be followed down the forearm to their various points of origin. Begin with the *median vein.* This will lead us as far down as the root of the thumb. *The anterior ulnar* may be followed to the wrist, and *the posterior ulnar* to the dorsum of the hand, where it is formed by the junction of a small vein from the back of the little finger, and another from the dorsal venous arch of the hand. *The radial vein* on the outer side of the forearm springs from the outer end of this arch.

Cutaneous Nerves.—Upon the *outer aspect* of the forearm, the student must trace out the following cutaneous nerves:—(1.) *Cutaneous part* of the *musculo-cutaneous*, which spreads out chiefly upon the anterior aspect of the limb. (2.) *External cutaneous branch* of the *musculo-spiral*, which is mainly distributed to the skin posteriorly. (3.) The *radial nerve.* This nerve is found in the lower third of the radial margin of the forearm, as it emerges from under cover of the tendon of the supinator longus. It gives a few twigs to the back of the forearm, but its chief distribution is upon the dorsum of the hand, where it divides into the dorsal collateral branches for the thumb, index, middle, and the radial side of the ring fingers. In many cases its area of supply stops short at the radial side of the middle finger, in which case an additional branch from the ulnar is given for the supply of the ulnar side of the medius and the radial side of the ring finger.

Upon the *inner aspect* of the forearm the dissector must dissect out the *anterior* and *posterior* branches of the *internal cutaneous* and the *dorsal* branch of the *ulnar*. The latter emerges from under cover of the tendon of the flexor carpi ulnaris, and will be found passing downwards over the dorsal aspect of the wrist close to the outer side of the styloid process of the ulna. It ends by giving dorsal digital twigs to the minimus and to the ulnar margin of the ring finger. It likewise sends a communicating branch to the radial nerve on the back of the hand. To trace the digital nerves from the ulnar and radial in their course along the fingers, the skin must be reflected from each finger by a vertical incision along its middle.

In the *front* of the forearm a small *palmar cutaneous twig* from the *ulnar* nerve will be found piercing the deep fascia to the outer side of the tendon of the flexor carpi ulnaris, and about three inches above the wrist. A small *palmar cutaneous nerve* from the *median* must also be sought for in the middle line of the limb about two inches above the wrist.

Deep Fascia—The fascia enveloping the forearm should now be cleaned by removing the subcutaneous adipose tissue. Note the great strength of this fascia, and this more especially in the lower third of the forearm, where the fleshy bellies of the subjacent muscles give place to the tendons. Remove the fascia from the front of the forearm. This can only be done in part, because the muscles which spring by a common origin from the internal condyle of the humerus are all more or less inseparably united to it at this point, as well as to the septa which it sends down between them. In dissecting the aponeurosis round the ulnar margin of the limb note its firm attachment to the posterior border of the ulna.

FRONT AND INNER BORDER OF FOREARM.

In this region we have to dissect out the following structures :—

(1.) The radial and ulnar arteries and their branches.
(2.) The ulnar and median nerves and their branches; also the posterior interosseous and radial nerves.
(3.) The pronator and flexor muscles.

Radial Artery.—When an artery lies superficially in its whole course through a particular region, it is a good rule to begin the dissection of the region by cleaning it and the parts in immediate relation to it, before we disturb the neighbouring muscles. In this way the dissector obtains a very much better idea of the relations of the vessel. We followed this rule with the brachial artery, and now let us do likewise with the radial artery, which, like the brachial, is not covered by any muscular structure in its course through the forearm. It is closely accompanied by the venæ comites. In order that its posterior relations may be clearly made out the various muscles having attachment to and clothing the anterior aspect of the radius must be cleaned. The branches of this vessel are—(1.) The *radial recurrent*, which we have already seen; (2.) *Muscular* branches coming off at various points; (3.) *Superficialis volæ*, springing from the artery a short distance above the wrist and passing downwards towards the ball of the thumb; (4.) The *anterior carpal*.

Superficial Muscles.—Now clean the muscles, beginning with the pronator radii teres and its two heads of origin, and then working successively at the flexor carpi radialis, the palmaris longus, the flexor sublimis digitorum, and the flexor carpi ulnaris. The supinator longus, which lies along the outer side of the limb, may also be cleaned at the same time. Reaching the lower third of the forearm, the dissector will observe that the flexor tendons, as they pass under cover of the anterior annular ligament, are enveloped by a loose bursal sac. A good view of this may be obtained by pulling the tendons upwards. The sac must on no account be removed or even punctured.

Ulnar Artery.—Although this vessel in the first part of its course passes obliquely under cover of those muscles which take common origin from the internal condyle of the humerus, its relations can be readily studied without reflecting any of them. It is merely necessary to slit up the intermuscular septum between the flexor sublimis digitorum and the flexor carpi ulnaris. It passes from the forearm into the palm by crossing the anterior annular ligament under shelter of the pisiform bone, and here it is bound down, with the ulnar nerve, to the ligament by a strong band of fascia, which is derived from the tendon of the flexor carpi ulnaris. The student is very apt to mistake these strong fibres for the anterior annular ligament itself. The ulnar artery gives off the following branches:—(1.) *The anterior ulnar recurrent*, which runs upwards in front of the internal condyle of the humerus; (2.) *The posterior ulnar recurrent*, which passes deeply under cover of the flexor sublimis and then upwards between the heads of the flexor carpi ulnaris to the interval between the olecranon and the internal condyle; (3.) *The interosseous*, which passes directly backwards and almost immediately divides into its anterior and posterior branches. These cannot be traced at present; (4.) *Muscular branches;* (5.) *The anterior* and *posterior carpal arteries.*

Nerves.—*The ulnar nerve* must be followed upwards to the point at which it enters the forearm between the two heads of the flexor carpi ulnaris. Its branches of supply to that muscle and to the inner part of the flexor profundus digitorum are given off high up in the forearm. Its articular twigs come off as it lies in the interval between the olecranon and the internal condyle of the humerus. *The radial nerve* will be seen springing from the musculo-spiral as the latter lies upon the supinator brevis muscle. It lies close to the outer side of the radial artery in the middle third of the forearm, and then leaves it by winding round the outer margin of the limb under cover of the tendon of the supinator longus. It gives off no branches until it becomes superficial. *The posterior interosseous* nerve, the other terminal branch of the musculo-spiral, will be observed to disappear from view by passing backwards through the fibres of the supinator brevis. *The median nerve*, as its name implies, passes down the middle of the forearm, and, to obtain an unbroken view of it, the dissector must reflect the condylar origin of the pronator teres and the radial origin of the flexor sublimis digitorum. Accompanying the nerve is an artery, the *median* branch of the anterior interosseous artery—usually small, but sometimes it attains a considerable size. The branches which the median gives to the flexor muscles and the pronator teres come off from it shortly after it has entered the forearm. A long slender branch called the anterior interosseous nerve will be seen to sink into the interval between the flexor longus pollicis muscle and the flexor profundus digitorum. It accompanies the anterior interosseous artery, and supplying the muscles between which it lies, it ends in the pronator quadratus. It should be noted that the median gives no branch to the flexor carpi ulnaris, and that those twigs which enter the flexor profundus only supply its outer part, or that part from which the tendons for the index and middle fingers arise.

Deep Muscles.—Clean and study the connections of the deep muscles. These are the flexor profundus digitorum on the inside, the flexor longus pollicis to the outer side, and the pronator quadratus muscle which lies over the lower ends of the bones. Lastly, follow the *anterior interosseous* artery downwards, dissect out the two nutrient branches which it gives to the bones of the forearm, and notice how it sends its perforating branch backwards through the interosseous membrane near the level of the upper border of the pronator quadratus.

PALM OF THE HAND.

Here we find :—

(1.) Palmaris brevis and two cutaneous nerves.
(2.) Palmar fascia.
(3.) Superficial palmar arch and its branches.
(4.) Median and ulnar nerves and their branches.
(5.) Anterior annular ligament, the flexor tendons, and the flexor sheaths.
(6.) Lumbrical muscles.
(7.) Short muscles of the thumb and little finger.
(8.) Deep palmar arch and its branches.
(9.) Arteria princeps pollicis and arteria radialis indicis.

Reflection of Skin.—*Incisions.*—(1.) A vertical incision along the middle line of the palm. (2.) A transverse cut at the extremity of this from the ulnar to the radial margin of the palm across the roots of the fingers. The skin is tightly bound down to the subjacent deep fascia. The transverse ligament at the roots of the fingers should be noticed as the skin is being reflected.

Superficial Structures.—The *palmaris brevis* muscle must first be displayed. Carry the knife transversely inwards through the granular fat on the ulnar margin of the palm immediately below the anterior annular ligament. The fleshy fibres of the muscle will come into view, and these must be cleaned. Next trace the *palmar cutaneous twigs* from the median and ulnar nerves to their terminations, and then remove the fatty tissue which conceals the palmar fascia.

Palmar Fascia.—Follow the four slips into which the central portion divides, and make out their connections at the roots of the fingers. Between the slips the digital vessels and nerves will be seen. Observe the transverse fibres which bind the slips together, and note the great contrast in strength and density between the central part of the fascia and the thin lateral portions which invest the short muscles of the thumb and little finger. Reflect the palmar fascia by dividing it transversely below the anterior annular ligament and throwing it downwards towards the fingers.

Superficial Palmar Arch.—This is the most superficial of the structures now exposed. Study carefully its mode of formation, and follow its digital branches. For this purpose it will be necessary to reflect the skin from the front of the fingers by making a vertical incision along the middle line of each. The *ulnar* artery will be seen to take the chief part in forming the arch. On the outer side of the palm the *superficialis volæ* may be traced downwards through some of the muscular fibres of the ball of the thumb to join the terminal branch of the ulnar, and thus complete the arterial arcade. The branches which it gives off are—(1.) *The profunda*, which sinks from view with the nerve of the same name between the abductor and flexor brevis minimi digiti; (2.) *Four digital arteries* from the convexity of the arch to supply both sides of each of the three inner fingers and the ulnar side of the index; (3.) *Minute recurrent twigs* from the concavity.

Nerves.—The nerves next claim the attention of the student; and, in the first place, he must note how they enter the palm. *The ulnar* passes *superficial* to the anterior annular ligament; the *median* reaches the palm by passing *under cover* of that ligament. Trace each nerve to its distribution. The ulnar soon divides into a *superficial* and a *deep* division. The *deep division* accompanies the profunda artery. The *superficial division* supplies a twig to the palmaris brevis, and ends by dividing into the palmar collateral branches for the little finger and the ulnar margin of the ring finger. The *muscular* branches of the median are especially liable to injury, and must therefore be sought for carefully. That to the outer head of the flexor brevis pollicis, the opponens pollicis, and abductor pollicis comes off almost on a line with the lower margin of the anterior annular ligament. The twigs to the two outer lumbricals spring, the one from the digital nerve to the radial side of the index, and the other from the nerve which bifurcates at the cleft between the index and middle fingers. The *digital* branches of the median may be traced to both sides of the thumb, index, and middle fingers, and to the radial margin of the ring finger.

Anterior Annular Ligament.—This should now be studied. Observe how it stretches across the arch of the carpus so as to form a tunnel, through which pass the tendons of the flexor sublimis, flexor profundus, and flexor longus pollicis, along with the median nerve. Make out its precise connections and relations, and note how it is pierced at its external attachment by the tendon of the flexor carpi radialis.

The synovial sac which lines the canal and envelopes the tendons and nerve deserves a very careful examination, and if it has not been injured its extent may be strikingly demonstrated by inflating it by means of a blow-pipe.

The Flexor Sheaths binding the two tendons to the anterior aspect of the fingers should be cleaned and examined, and then opened by a vertical cut along the middle line of the fingers. The synovial lining, the mode of insertion of the two tendons, and the vincula accessoria can now be made out.

DEEP DISSECTION OF PALM.

Throw forward the superficial palmar arch and the median and ulnar nerves. To do this the ulnar artery must be severed immediately below the point at which it gives off the profunda branch.

Now divide the annular ligament at its middle, and cutting through the fleshy belly of the flexor sublimis digitorum, raise the tendons from the hollow of the carpus and throw them forwards as far as the roots of the fingers. After examining the *four lumbrical muscles*, the same course must be followed with the flexor profundus digitorum. The deep palmar arch and its branches and the deep branch of the ulnar nerve must now be carefully dissected out, and at the same time the short muscles of the thumb and little finger cleaned and separated from each other.

Short Muscles of the Thumb.—The *abductor pollicis* forms the most prominent and external part of the ball of the thumb. The *outer* or *superficial head* of the *flexor brevis pollicis* lies immediately to the inner side of this muscle, and separating the one from the other, the *opponens pollicis* will be exposed. These three muscles lie to the outer side of the tendon of the flexor longus pollicis. To the inner side of this tendon, and lying deeply in the palm, are the *inner* or *deep head* of the *flexor brevis* and the *adductor pollicis*. The line of origin of these two muscles is quite continuous, so that at first sight they seem to constitute a single muscle.

Short Muscles of the Little Finger.—The *abductor minimi digiti* lies to the inside, and the *flexor brevis* to the outside. On separating these from each other, the *opponens* is seen in the interval between them.

Deep Palmar Arch is mainly formed by the radial which appears in the palm by coming forward between the inner head of flexor brevis pollicis and the adductor pollicis. The arch is completed on the inner side by the profunda branch of the ulnar artery. *Interosseous*, *recurrent*, and *perforating* branches spring from it.

Deep Branch of the Ulnar Nerve.—This is found running alongside of the arch and ending in the adductor pollicis and the inner head of flexor brevis pollicis. Besides these muscles it supplies twigs to the three short muscles of the little finger, to all the interossei muscles, both dorsal and palmar, and to the two inner lumbrical muscles. These nerves are very minute, and great caution and patience must be exercised in following them to their destinations.*

The Radialis Indicis Artery and **the Princeps Pollicis Artery** can now be exposed. They come

* It will not be out of place to mention at this stage an exceedingly ingenious plan of teaching the nervous supply of the intrinsic muscles of the hand devised by Dr. J. A. Russell, formerly senior demonstrator of anatomy in this University. He points out that these muscles are naturally divided into two groups by the tendon of the flexor longus pollicis—viz., (1.) The abductor, outer head of flexor and opponens pollicis lying to the *radial* side of the tendon ; and (2.) The three short muscles of little finger, the interossei, the palmaris brevis, the lumbricals, and the adductor and inner head of the flexor brevis pollicis placed upon the *ulnar* side of the tendon. Now, all the muscles of the *first group* are supplied by the median nerve, and all the muscles of the *second group*, with two exceptions, are supplied by the ulnar nerve. These two exceptions are the two outer lumbricals which are supplied by the median.

But still further, Dr. Russell explains why the lumbricals are exceptional to the general rule. These muscles are associated with the flexor profundus digitorum, from the tendons of which they spring, and it will be remembered that the inner portion of this muscle is supplied by the ulnar ; so are the lumbricals in connection with it. Again, the outer part of the flexor profundus is supplied by the median, and so are the lumbricals which arise from the two outer tendons.

off from the radial as it passes forwards between the first and second metacarpal bones. The first is displayed by reflecting the adductor pollicis, and the latter by reflecting the inner head of the flexor brevis pollicis. Trace them in their course upon the index and thumb respectively.

BACK AND OUTER BORDER OF FOREARM.

The cutaneous nerves and vessels in this locality have already been studied. The parts which still require dissection are:—

(1.) The deep fascia.
(2.) The supinator and extensor muscles.
(3.) The posterior interosseous artery.
(4.) The perforating branch of the anterior interosseous artery.
(5.) The posterior interosseous nerve and its branches.

Deep Fascia and Superficial Muscles.—In removing the deep fascia it will be found to be inseparably connected near the elbow-joint with the muscles which spring from the external condyle. Here, then, it will be necessary to let it remain undisturbed. The fascia being raised, the superficial layer of muscles must be cleaned. The supinator longus has already been cleared of its sheath, but proceeding inwards from this the student will meet in with the extensor carpi radialis longior, the extensor carpi radialis brevior, the extensor communis digitorum, the extensor minimi digiti, and the extensor carpi ulnaris. Further, the tendons of the extensor ossis metacarpi pollicis and extensor primi internodii pollicis will be seen coming out between the extensor communis and the extensor carpi radialis brevior in the lower third of the forearm.

The next step in the dissection consists in reflecting the extensor communis digitorum and extensor minimi digiti. Do this by cutting through the fleshy belly about its middle, and throwing the parts upwards and downwards. Proceed with caution, so as to avoid injury to the nerve-twigs from the posterior interosseous nerve, which enter them on their deep surface.

The Deep Muscles are now exposed, but before cleaning these, trace the nerves and arteries to their distribution. The *posterior interosseous nerve* will be seen immerging from the substance of the supinator brevis. Follow its branches to the different muscles and also its terminal branch, which will subsequently be seen to end on the posterior aspect of the wrist-joint. The *posterior interosseous artery* appears in the interval between the supinator brevis and extensor ossis metacarpi pollicis. It exhausts itself in the supply of the muscles and anastomoses with the anterior interosseous. The *perforating branch* of the *anterior interosseous artery* enters the extensor aspect of the forearm by piercing the interosseous membrane at the upper border of the pronator quadratus. Follow it downwards to the wrist.

The deep muscles must in the next place be examined. From above downwards, the dissector will meet with the supinator brevis, the extensor ossis metacarpi pollicis, the extensor primi internodii pollicis, the extensor secundi internodii pollicis, and the extensor indicis.

Lastly, reflect the *anconeus* muscle by detaching it from the external condyle and throwing it inwards towards its insertion. This will give the dissector a better view of the supinator brevis, and display the *recurrent branch* of the posterior interosseous artery ascending to the back of the external condyle.

The Anastomosis around the elbow-joint should now be reviewed as a whole. A distinct inosculation will be found to take place upon both the anterior and posterior aspect of each condyle of the humerus. Behind the external condyle the *posterior interosseous recurrent* joins the *posterior branch* of the *superior profunda;* in front of the same condyle the *anterior branch* of the *superior profunda* communicates with the *radial recurrent.* On the inner side of the joint the *anterior* and *posterior ulnar recurrent* arteries ascend respectively in front of and behind the internal condyle, and anastomose, the former with the *anterior branch of the anastomotic*, and the latter with both the *anastomotic* and the *inferior profunda.*

DORSAL ASPECT OF THE WRIST AND HAND.

There still remain to be examined in this locality :—

(1.) The radial artery and its branches.
(2.) The posterior annular ligament.
(3.) The extensor tendons.

It is only a very small part of the radial which is found in relation to the wrist. Note how it is crossed by the three extensor tendons of the thumb and sinks from view between the two heads of the first dorsal interosseous muscle. Its branches are very minute, and can only be dissected in a well-injected subject. They are—(1.) The *posterior carpal*, which runs inwards under the extensor tendons to join the posterior carpal branch of the ulnar. From the arch thus formed two twigs are given to the *third* and *fourth interosseous spaces*. (2.) The *first dorsal interosseous* branch to the second interosseous space. (3.) The *dorsalis indicis*. (4.) The *dorsalis pollicis*—sometimes two in number.

Posterior Annular Ligament.—The oblique direction of this ligament is owing to its being attached to the styloid process of the radius on the outside, and the hook of the unciform bone and the pisiform bone on the inside. These attachments interfere in no way with the free movements of pronation and supination. Contrast this ligament with the anterior annular ligament. In the latter case there is formed a single compartment or tunnel for the nine flexor tendons; here processes or septa pass from deep surface of the ligament to the ridges on the back of radius, and six compartments are formed, each containing its own tendon or tendons. Open these compartments, and note the tendons which belong to each and the synovial membrane lining the compartments.

Extensor Tendons.—Follow these tendons to their insertions. In the case of those which go to the digits especial care must be taken in cleaning the dorsal expansion on the back of the first phalanx of each finger. The tendons of insertion of the lumbricales and interossei muscles will be seen joining this.

Posterior Interosseous Nerve.—In the forearm the terminal branch of this nerve sinks under cover of the extensor secundi internodii pollicis, and should now be followed to the back of the wrist, where it ends in a gangliform enlargement, from which articular twigs proceed.

Interossei Muscles.—These must be dissected both on the palmar and dorsal aspects of the hand. The four dorsal will be found one in each intermetacarpal space. The three palmar lie in relation to the metacarpal bones of the index, ring, and little fingers.

The articulations of the upper limb should now be dissected. In doing this follow the method recommended in your text-book of Practical Anatomy.

INFERIOR EXTREMITY.

LOWER LIMB.

On the morning of the second day, after the subject is brought into the Rooms, it is placed upon the table with its face downwards and its chest and pelvis supported with blocks. (Pl. III. p. 2). In this position it is allowed to remain for *four* days, and in this time the dissector of the lower limb has a very extensive dissection to perform. He has to dissect—(1.) The gluteal region; (2.) The popliteal space; and (3.) The back of the thigh. With so much work before him, and being limited as to the time in which it must be done, it is very necessary that he should apportion the four days at his disposal so as to be ready for the turning of the body. The *first two days* he should devote exclusively to the study of the gluteal region; the *third day* may be given to the popliteal space; and on the *fourth day* he should undertake the dissection of the back of the thigh, and revise the work of the three preceding days.

GLUTEAL REGION.

In this region we have the following parts to dissect and examine after the skin has been reflected :—

(1.) Superficial fascia.
(2.) Cutaneous nerves and blood-vessels.
(3.) Deep fascia.
(4.) The gluteus maximus : (and after this has been reflected),
(5.) Three synovial bursæ.
(6.) Gluteus medius and minimus.
(7.) Pyriformis.
(8.) The two gemelli and the tendon of the obturator internus.
(9.) The tendon of the obturator externus.
(10.) The quadratus femoris.
(11.) Upper border of the adductor magnus.
(12.) The origin of the hamstrings from the tuberosity of the ischium.
(13.) The upper part of the vastus externus.
(14.) The great sacro-sciatic ligament.
(15.) Blood-vessels.
- Gluteal.
- Sciatic.
- Pudic.
- Obturator.
- Internal circumflex.

(16.) Nerves.
- Superior gluteal.
- Great sciatic.
- Small sciatic.
- Pudic.
- Nerve to obturator internus.
- Nerve to quadratus femoris.
- Special branches to gluteus maximus.

Supposing that two days are allowed for the above dissection, the *first day's* work should consist—(1.) In the dissection of the parts superficial to the gluteus maximus; (2.) In the cleaning and reflecting of this muscle; (3.) In tracing and defining the various nerves and blood-vessels which enter its deep surface. On the *second day* the parts which are exposed by the reflection of the gluteus maximus should be dissected.

Reflection of Skin.—*Incisions.*—(1.) From the posterior superior spine of the ilium in a curved direction outwards, following the crest of the ilium, as far forwards as the position of the body will permit. (2.) From the posterior extremity of this curved incision obliquely downwards and inwards to the middle line of the sacral region, and then perpendicularly downwards to the tip of the coccyx. (3.) From the tip of the coccyx obliquely downwards and outwards over the back of the thigh in a direction parallel to, but at a lower level than, the fold of the nates. (Pl. III. p. 2, and Pl. I.)

A large flap of skin is thus marked out, and this must be raised from the subjacent superficial fascia and thrown outwards. On the right side of the body the dissector begins at the crest of the ilium and works downward and forwards, whilst on the left side he commences over the coccyx and works upwards and forwards.

Superficial Fascia.—The superficial fascia is now exposed, and it is seen to partake of the same characters as the corresponding layer of fascia in other parts of the body. Notice, however, its special peculiarities in this region. How it is much more heavily laden with fat—especially in the female; how it thickens over the lower margin of the gluteus maximus, and how it becomes tough, elastic, and stringy over the ischial tuberosity, so as to form a most effective cushion upon which this bony prominence may rest while the body is in the sitting posture.

Cutaneous Nerves.—The superficial fascia forms a bed in which the cutaneous nerves ramify before they enter the skin. In this region the cutaneous nerves are very numerous, and they are derived from a great variety of sources. Some proceed from the *posterior* primary divisions of the spinal nerves, whilst others are branches of the *anterior* primary divisions of the spinal nerves.

From the *posterior primary divisions* there are usually *six—three* from the *sacral* nerves, and three from the *lumbar* nerves. The *three sacral nerves* reach the surface by piercing the gluteus maximus muscle close to its origin from the sacrum and coccyx. They pierce the muscle in a line drawn from the posterior superior iliac spine to the tip of the coccyx. The largest is found opposite the lowest piece of the sacrum, the highest about an inch above this, and the lowest about the same distance below it. Owing to the coarseness of the muscular fasciculi between which they appear, they are somewhat difficult to find. In looking for them it is best to cut right down through both superficial and deep fasciæ, so as to secure them as they emerge from the muscle.

The *three lumbar nerves* are easily found. They cross the crest of the ilium at a point corresponding to the outer limit of the attachment of the erector spinæ to the innominate bone. Trace them downwards as they ramify in the superficial fascia. A few twigs may be followed as far as the great trochanter.

The cutaneous twigs which come from the *anterior primary divisions* of the spinal nerves may be classified under three headings—(1.) Those which pass downwards over the crest of the ilium. (2.) Those which pass backwards over the insertion of the gluteus maximus into the fascia lata. (3.) Those which turn upwards around the lower margin of the gluteus maximus.

The nerves which cross the crest of the ilium are—(1.) The *iliac branch* of the *ilio-hypogastric* nerve, and (2.) The *iliac branch* (*i.e.*, the lateral cutaneous branch) of the *last dorsal* nerve. The latter lies a very short distance in front of the former, and is the larger of the two. They cross the iliac crest about two and a-half inches behind the anterior superior spine of the ilium. In the superficial fascia they spread out into a great number of fine twigs, some of which reach downwards as far as the level of the great trochanter.

The nerves which pass backwards over the insertion of the gluteus maximus are a few small branches of the *external cutaneous nerve* of the thigh. They are found above the level of the great trochanter.

The cutaneous twigs which hook round the lower margin of the gluteus maximus muscle to reach the skin over this region are a few offsets from the *small sciatic nerve*, and they can be very readily found by cutting directly down upon the muscle in this position, and carrying the knife in a direction transverse to that of the muscular fibres. They appear at different levels, and are in some cases accompanied by small arterial twigs from the sciatic artery.

The Deep Fascia, in the next place, claims the attention of the dissector. This is brought into view by removing the remnants of the superficial fascia. Observe the marked contrast between the fascia covering the gluteus maximus and that clothing the anterior exposed portion of the gluteus medius. Over the gluteus maximus, it is present in the form of a thin transparent layer, through which the muscular fibres are plainly visible, whilst over the gluteus medius it constitutes a strong, opaque, pearly-white aponeurosis, which is firmly attached by its upper limit to the crest of the ilium.

Gluteus Maximus.—Now proceed to clean this muscle. If it is the right limb, begin at the anterior or upper margin of the muscle; but if it is the left, commence the dissection at the posterior or lower border. In undertaking this dissection, the dissector must keep clearly before him the rules which have already been laid down regarding the cleaning of a muscle:—(1.) Render the fibres as tense as possible by rotating the limb *inwards*. (2.) Remove the fascia in one continuous layer. (3.) Always cut in the direction of the muscular fibres, which in this case corresponds with a line drawn from the sacrum to the great trochanter. (4.) Define very carefully the borders of the muscle.

The gluteus maximus is a difficult muscle to clean, the fasciculi are so exceedingly coarse and rough. To do it well, it is not sufficient to remove the fascia which covers the muscle, but it is necessary at the same time to follow, for a short distance, the septa which penetrate between the fasciculi, and to remove them also.

The dissector of the left limb, on reaching the anterior margin of the muscle, will observe that the fascia which he holds in his hand is continuous with the strong aponeurosis which covers the gluteus medius; and further, if he now frees the anterior border of the muscle from subjacent parts, he will notice that the layer of fascia upon which the gluteus maximus rests is also continuous with the same aponeurosis. In other words, he will in this manner be able to satisfy himself that the strong fascia which covers the anterior part of the gluteus medius splits into two layers to enclose the gluteus maximus. The small sciatic nerve lies in very close relation to the deep surface of the muscle, not far from the posterior border, and is very apt to be injured in the subsequent steps of the dissection, unless it be secured at once by everting the posterior border of the muscle.

Reflection of Gluteus Maximus.—This is the next step in the dissection of this region, and it is one which demands the utmost care upon the part of the dissector, owing to the close connection of the muscle with important structures which lie subjacent to it. It must be thrown down from its origin. Begin by freeing the anterior and posterior borders of the muscle, and introducing the hand underneath it. Now, with the left hand still under the muscle (supposing that it is the left side of the body), detach the muscular fibres in turn from the dorsum ilii, sacrum, coccyx, and great sacro-sciatic ligament.* In removing the muscle from the latter attachment, the *coccygeal* branch of the sciatic artery which pierces the ligament is necessarily cut. As we continue to turn the muscle downwards, numerous blood-vessels and nerves are displayed, sinking into its substance. The arteries are—(1.) The *superficial* division of the *gluteal* artery; and (2.) Branches of the *sciatic* artery. The former enter the muscle at a higher level than the latter. The nerves are—(1.) Some *special* branches from the *sacral plexus*; and (2.) A few twigs from the *small sciatic* nerve. These vessels and nerves must be very carefully cleaned and isolated, and then, in order that the muscle may be fully reflected, they must be divided. In doing this it is well to leave attached to each a portion of muscle substance, so that they may be afterwards recognised as the vessels and nerves of supply to the gluteus maximus.

On the *second day* the dissector undertakes the dissection of those structures which are displayed by the reflection of the gluteus maximus.

* On the right side of the body begin at the coccyx, and work upwards.

The tuber ischii, and the great trochanter are now exposed to view, and a *bursa* in connection with each may be demonstrated. That in relation to the great trochanter is of very large size, and is directly interposed between the muscle and the external surface of the bone. Open it with the knife, and estimate its extent by introducing the finger. Note the thinness of its walls, and further, that it usually consists of one sac. Next examine in a similar manner the bursa in connection with the tuber ischii. It will be found upon the inferior aspect of this prominence, and the dissector will not fail to observe that it lies more between the tough superficial fascia and bone, than between the muscle and bone. A *third bursa* will be found intervening between the vastus externus and the gluteus maximus.

The insertion of the gluteus maximus can now be demonstrated in a satisfactory manner.

In the next place define and clean the muscles, blood-vessels, and nerves, by removing the loose areolar tissue which clothes and passes in between them. The following muscles will be recognised as we pass from above downwards:—(1.) The gluteus medius; (2.) The pyriformis, issuing from the pelvis through the great sacro-sciatic foramen; (3.) The tendon of the obturator internus, with the gemellus superior attached to its upper border, and the gemellus inferior to its lower border; (4.) The quadratus femoris; (5.) The upper border of the adductor magnus. By separating the quadratus from the gemellus inferior, the tendon of the obturator externus will be revealed as it passes round the neck of the femur to reach the digital fossa. Lastly, the origin of the hamstring muscles from the tuber ischii, and the upper part of the vastus externus in relation to the root of the great trochanter, should be noted.

In each interval formed by the adjacent margins of these muscles, blood-vessels or nerves, or both, are to be found. Before proceeding to the dissection of these, however, it is well that the student should renew his acquaintance with the skeletal peculiarities of this region. Let him obtain a dried pelvis with the ligaments *in situ*, and study carefully the position and boundaries of the great and small sciatic notches, and how they are converted into foramina by the small and great sacro-sciatic ligaments. Through these foramina most important structures issue from the interior of the pelvis into the gluteal region.

With the knowledge thus acquired, let him return to his dissection and dissect out the blood-vessels and nerves of the region.

Gluteal Artery and Superior Gluteal Nerve.— In the interval between the pyriformis and the gluteus medius, the gluteal artery and the superior gluteal nerve will be seen to emerge from the pelvis through the great sacro-sciatic foramen. The artery at once divides into a *superficial* and *deep* division. The distribution of the former has already been noted. It has been seen to sink into the deep surface of the gluteus maximus.

The nerve and the *deep division* of the artery are distributed under cover of the gluteus medius. It becomes necessary, therefore, to reflect this muscle.

Except where it is attached to the crest, the gluteus medius can be very readily detached from the dorsum ilii with the handle of the knife. Its inferior limit of origin is clearly indicated by a large artery which runs along the superior curved line on the dorsum ilii —viz., the *superior* branch of the *deep* division of the gluteal. In throwing the muscle downwards, branches from the *superior gluteal* nerve and from the *deep division* of the gluteal artery will be seen to enter its deep surface, and it will be further observed that, anteriorly, it is more or less fused with the gluteus minimus. Follow out the gluteal nerve and artery. Note the branch of the nerve which enters the gluteus minimus, and also the twig which passes outwards to gain the tensor fasciæ femoris. The *superior* and *inferior* branches of the deep gluteal artery must in like manner be traced to their terminations.

In the interval between the pyriformis and superior gemellus, *two* arteries with their accompanying veins and *six* nerves issue from the lower part of the great sacro-sciatic foramen.

Arteries.
- (1.) Sciatic.
- (2.) Pudic.

Nerves.
- (1.) Great sciatic.
- (2.) Small sciatic.
- (3.) Pudic.
- (4.) Nerve to the obturator internus.
- (5.) Nerve to the quadratus femoris.
- (6.) Special nerve to the gluteus maximus.

Sciatic Nerves and Vessels.—In cleaning the *great sciatic* nerve be careful not to remove a minute artery—*the comes nervi ischiadici*—which enters its substance and passes downwards amidst its fibres. The *small sciatic* nerve should also be more fully dissected out. The branches which it gives to the gluteus maximus and to the skin over the gluteus maximus have been divided. A few cutaneous twigs to the skin on the inner aspect of the thigh and its *long pudendal* branch must now be found.

In a well-injected body the anastomosis between the sciatic artery and the internal circumflex as it appears between the contiguous borders of the adductor magnus and quadratus femoris may be made out. Of the three named branches which proceed from the *small sciatic* artery two have been already observed—viz., the coccygeal and the comes nervi ischiadici; the third, the artery to the quadratus femoris, accompanies the nerve to that muscle, and will be found lying close beside it.

Pudic Vessels and Nerves, and the Nerve to the Obturator Internus.—These will be found upon the spine of the ischium under cover of the great sciatic ligament, and a careful dissector can readily trace a delicate twig to the gemellus superior from the nerve to the obturator internus.

The Nerve to the Quadratus Femoris lies under cover of the great sciatic nerve. Consequently, the first step to its discovery consists in drawing aside this large nervous trunk. It passes downwards and disappears under cover of the gemelli and obturator internus to reach the quadratus. On its way it gives a small offset to the gemellus inferior. It is accompanied by a small arterial twig from the sciatic artery.

Obturator and Internal Circumflex Arteries.—In the interval between the quadratus femoris and gemellus inferior we find a small branch of the internal circumflex artery, and sometimes a minute arterial twig from *the obturator artery.* In the interval between the margins of the quadratus and adductor magnus the termination of the *internal circumflex* artery will be discovered.

Reflection of Gluteus Minimus, Obturator Internus, and Quadratus Femoris.—The last step in the dissection of the gluteal region consists in the reflection of three muscles—viz., the gluteus minimus, the obturator internus, and the quadratus femoris.

The gluteus minimus must be detached from its origin and thrown downwards. We have three objects in view in undertaking this dissection—(1.) The display of the posterior surface of the capsular ligament of the hip-joint; (2.) The demonstration of a bursa which intervenes between the tendon of the muscle and the great trochanter; (3.) The exhibition of the reflected tendon of the rectus femoris which arises from the dorsum of the acetabulum.

The tendon of the obturator internus should be divided close to its insertion into the upper margin of the great trochanter. On turning it backwards we bring into view a synovial sac which intervenes between the muscle and the small sciatic notch. We further observe how the little ridges of the cartilaginous coating of the notch fit into fissures in the deep aspect of the tendon of the muscle.

The quadratus femoris should be detached from the tuberosity of the ischium and thrown outwards towards its femoral attachment. This proceeding gives us a more extensive view of the obturator externus muscle.

POPLITEAL SPACE.

Before the muscles on the back of the thigh are disturbed, it is well to dissect the popliteal space. In this way the boundaries of the space are maintained in position during our examination of the structures which lie within it.

The following is a list of the structures which require to be studied :—

(1.) Superficial fascia.
(2.) External saphenous vein.
(3.) Small sciatic nerve.
(4.) Popliteal fascia.
(5.) Muscles which bound the space. — Biceps. Semitendinosus. Semimembranosus. Gastrocnemius. Plantaris.
(6.) The internal and external popliteal nerves and their branches.
(7.) The popliteal artery and vein and their branches.
(8.) A few lymphatic glands.
(9.) A slender branch from the obturator nerve.
(10.) The popliteus muscle.

A good-sized block should, in the first place, be inserted under the knee, so as to support the limb, and render the muscles which bound the space tense.

In the study of an anatomical space, the structures which we meet with in our dissection should be examined in a definite order. *The coverings* of the space should first engage our attention; then we should proceed to define *the boundaries;* next we should dissect out and isolate *the contents;* lastly, *the floor* should be cleaned, and the parts entering into its formation recognised (*vide* p. 31).

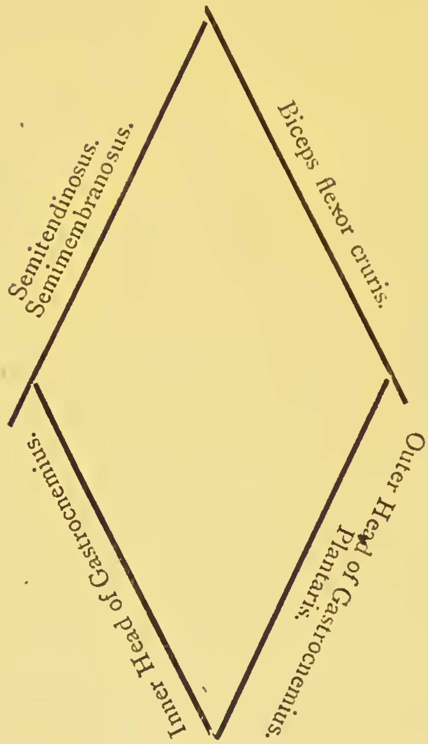
Coverings—Reflection of Skin.—*Incisions.*—(1.) A vertical incision along the middle line of the limb beginning about five inches above, and terminating about four inches below the bend of the knee; (2.) A transverse incision at the upper end of the mesial incision; (3.) A transverse incision at the lower extremity of the mesial incision. The two transverse incisions should extend almost half way round the limb. (Pl. I., and Pl. III. p. 2.)

Two flaps of skin are thus mapped out, and these must be raised and thrown the one inwards and the other outwards.

Superficial Fascia—External Saphenous Vein—Branches of Small Sciatic Nerve.—The fatty layer upon which the skin rests is now brought into view, and the cutaneous nerves and vessels must be secured. First look for a small nerve—a branch of the small sciatic—which passes downwards over the space near the middle line, and when this is found, dissect out the external saphenous vein. This vessel ascends in the middle line of the leg, and tracing it upwards it will be found to disappear from view by piercing the deep fascia, and entering the popliteal space. The terminal branch of the small sciatic nerve pierces the popliteal fascia at the lower part of the space, and here it will be seen lying close to the external saphenous vein.

Popliteal Fascia.—Great care must be taken in removing the superficial fascia from the deep popliteal fascia. Although thin, the deep fascia possesses considerable strength, owing to the transverse fibres which are interwoven amidst its proper aponeurotic fibres. In removing this fascia the dissector will notice that it is firmly attached on each side to the tendons of the muscles which bound the popliteal space.

Boundaries.—The structures which roof in the popliteal space being now removed, the dissector must in the next place proceed to define the boundaries. The space will now be seen to be diamond-shaped. Above, and to the outside, will be found the *biceps* muscle; whilst above, and to the inside, the *semitendinosus* and *semimembranosus* will be brought into view—the former lying upon the surface of the latter. In front of these the *sartorius*, *gracilis* and the tendon of the *adductor magnus* can be exposed. Below, the space is bounded by the converging heads of the *gastrocnemius*. In the formation of the lower and outer boundary, the outer head of the gastrocnemius will be seen to be assisted by the small *plantaris* muscle.



In cleaning these muscles there are certain points to be attended to. In the case of the outer head of the gastrocnemius, care must be taken not to remove the *nervus communicans fibularis* nerve, which passes downwards and inwards upon its surface. In the groove between the heads of this muscle will be seen the *nervus communicans tibialis.* Further, the dissector must not overlook the synovial bursa which intervenes between the tendon of the semimembranosus and the inner head of the gastrocnemius. This bursa sometimes communicates with a second synovial sac, which will be brought into view by lifting the inner head of the gastrocnemius. It will be observed to be interposed between this muscle and the inner condyle.

Contents.—These must next be carefully dissected out and cleaned by the removal of the soft fat which surrounds them.

Internal Popliteal Nerve.—This is the most superficial structure in the popliteal space. It is readily found by slightly separating the adipose tissue in the middle line of the space. The *nervus communicans tibialis*, which has been already secured, should now be followed upwards, and it will then be seen that it is a branch of the internal popliteal nerve. Follow the internal popliteal nerve downwards, and dissect out its various branches. The *three articular* nerves which spring from it and accompany the two internal articular arteries and the azygos articular artery must be sought for with the greatest care. In addition to these, it supplies *muscular* branches to the gastrocnemius, soleus, plantaris, and popliteus muscles.

External Popliteal Nerve.—This nerve will be discovered lying along the inner side of the biceps. It leaves the space by following the tendon of this muscle, and then it occupies the interval between the outer head of the gastrocnemius and the biceps. In tracing the nerve downwards secure the branches which it gives off, viz.—(1.) The *nervus communicans fibularis*, which has already been noticed on its way downwards over the outer head of the gastrocnemius; (2.) A few *cutaneous* twigs; (3.) *Two articular* nerves which accompany the two external articular arteries.

Popliteal Artery and Vein.—These lie in very close apposition—the vein superficial to the artery.

To reach the vein the student should take its external saphenous tributary as his guide. To the inner side of the vein, and at a deeper plane, the artery will be observed lying upon the femur.

In clearing away the fatty areolar tissue which surrounds these vessels, take note of two or three small *lymphatic glands* which lie embedded within it upon each side of the artery. Again great care must be taken in cleaning the vessels not to injure the obturator nerve which lies upon the coats of the artery.

It is impossible in the present dissection to expose the popliteal artery in its entire length. Its division into its two terminal branches (viz., the *anterior* and *posterior tibial*) at the lower border of the popliteus muscle is hidden from view by the soleus muscle. It gives off—(1.) *muscular*, (2.) *articular* branches.

Muscular branches may be followed to the ham-string muscles in the upper part of the space, and to the muscles of the calf in the lower portion of the space (*sural*). The *articular branches* are five in number—two superior, two inferior, and an azygos.

The *superior articular* arteries spring from the main trunk as it passes between the condyles of the femur. One proceeds from each side of the popliteal, and they are called *internal* and *external* according to the direc-tion which they take. They will be found resting directly upon the back of the femur, and they will be observed to incline slightly upwards, and then to wind round the bone immediately above the condyles. The external is the larger of the two. The student is very apt to mistake a muscular branch for one or other of these vessels, but their close apposition to the femur should in all cases be sufficient to distinguish them. By separating widely the upper boundaries of the space the *internal* artery may be traced to the point where it passes under cover of the long tendon of the adductor magnus, and the *external* to the point where it pierces the external intermuscular septum of the leg.

The Inferior Articular Arteries arise from the popliteal as it lies upon the posterior ligament of the knee-joint. The *external* passes outwards in a transverse direction. The *internal* takes an oblique course downwards and inwards along the upper margin of the popliteus muscle, and this is the best guide to the vessel.

The Azygos Articular Artery springs from the popliteal as it reaches the posterior ligament of the knee-joint. It pierces this ligament to reach the synovial membrane.

In carrying out the dissection of these arteries great care must be taken of the delicate articular nerves which accompany them.

Obturator Nerve.—This minute nerve will be found lying upon the popliteal artery. Trace it upwards, and it will be seen to enter the space by piercing the lower fibres of the adductor magnus; follow it downwards, and perhaps you may be able to see it entering the knee-joint by penetrating the posterior ligament.

Floor of the Space.—This must now be cleaned. Scrape the fatty tissue from the popliteal surface of the femur with the handle of the knife. The posterior ligament should also be thoroughly exposed. With regard to the popliteus, it is better not to interfere with the fascia covering its popliteal surface, as this must be examined on a future occasion in connection with the tendon of insertion of the semimembranosus muscle, of which it is an expansion.

BACK OF THE THIGH.

The dissection of the back of the thigh must be completed on the fourth day. The structures met with after the skin has been thrown back are :—

(1.) Superficial fascia.
(2.) Cutaneous nerves.
(3.) Deep fascia.
(4.) Muscles. { Biceps. Semitendinosus. Semimembranosus. Adductor magnus.
(5.) Nerves. { Small sciatic. Great sciatic.
(6.) Arteries. { Branch of external circumflex. Four perforating arteries.

Reflection of Skin.—A vertical incision must be made in the middle line of the thigh through the belt of skin which still encircles the thigh posteriorly. The two flaps can then be reflected, the one outwards and the other inwards. (Pl. I.)

Superficial Fascia—Cutaneous Nerves.—In the fatty superficial fascia thus brought into view cutaneous twigs from three sources must be looked for—(1.) Along the *middle line* of the limb a few minute branches of the *small sciatic* may be discovered ; (2.) Towards *the outer side* of the thigh some twigs from the *external cutaneous* nerve may be detected ; (3.) Lastly, towards *the inner aspect* of the limb endeavour to find some offsets from the *internal cutaneous* nerve.

Deep Fascia.—On removing the superficial fascia the deep fascia will be observed to be exceedingly thin. It must now be turned aside, and in doing this be careful of the trunk of the small sciatic nerve, which passes down in the middle line of the limb immediately subjacent to the fascia.

Hamstring Muscles.—The biceps is recognised from its diverging to form the outer and upper boundary of the popliteal space. The semitendinosus and semimembranosus extend downwards on the inner side of the thigh on its posterior aspect, and the former on the superficial aspect of the latter. In cleaning these muscles the dissector should proceed cautiously to work, otherwise he is certain to injure the arterial and nervous twigs which enter them. Observe the manner in which they arise from the tuber ischii ; how the conjoined tendon of the long head of the biceps and the semitendinosus lies superficial and internal to that of the semimembranosus. Define the precise attachment which the short head of the biceps has to the femur, and note the tendinous intersection of the semitendinosus and the tendinous expansion upon both superficial and deep aspects of the semimembranosus.

Great Sciatic Nerve.—Follow this nerve downwards to its division into the internal and external popliteal nerves. It will be found to give branches to each of the hamstrings and to the adductor magnus upon which it lies. In a few cases it may be observed to give off a long articular twig, which enters the popliteal space and accompanies the superior external articular artery.

Perforating Arteries.—Four perforating arteries will be found emerging from the surface of the adductor magnus muscle close to the linea aspera of the femur. They are called *first*, *second*, *third*, and *fourth* according to the level at which they appear from above downwards. The *fourth* is the terminal branch of the profunda artery of the thigh, and it makes its appearance about an inch above the opening in the muscle through which the popliteal artery enters the popliteal space. The perforating arteries and their branches must be thoroughly cleaned, but not only the arteries themselves, but also the apertures in the adductor magnus through which they pass. It will then be seen that they do not pierce the fleshy substance of the muscle. Prepared for each is a tendinous archway, and they reach the back of the thigh by passing between these and the linea aspera, to which the piers of the various arches are attached.

These openings lie in the same line and are in all respects analogous to the large opening in the same muscle for the popliteal artery, and the result obtained is the same in both cases. When the muscle contracts, the vessels are protected from pressure.

The *external circumflex* artery also sends a branch to the back of the thigh. In a well-injected subject the terminal twig of its middle division will be noticed appearing from amidst the fibres of the vastus externus at its upper part. It may be seen to anastomose with the first perforating and the internal circumflex.

The *internal circumflex* artery has already been observed in the gluteal region, appearing between the contiguous margins of the adductor magnus and the quadratus femoris muscles.

Adductor Magnus.—To bring this muscle more fully into view, and at the same time to facilitate the process of cleaning its radiating fibres, it is well to reflect the hamstring muscles from their origins. First divide the conjoined tendon of the biceps and semitendinosus. This displays the precise origin of the semimembranosus, and when the dissector has again looked at this under the present more advantageous circumstances, he should divide it also.

Anastomosis on the Posterior Aspect of the Limb.—In a well-injected subject a chain of anastomosis, in which every link is complete, can be traced from the gluteal region down the back of the thigh to the popliteal space. The present is the best time to study this. Commencing above, we find the gluteal artery anastomosing with the sciatic and the sciatic with the internal circumflex. In the back of the thigh this chain is carried downwards by the internal circumflex anastomosing with the first perforating, each perforating artery inosculating with the one below it, and lastly, the lower perforating arteries effecting junctions with the muscular branches which the popliteal artery gives to the hamstrings.

FRONT OF THE THIGH.

The body is now turned round so as to lie on its back. The pelvis is supported by two blocks, and the lower limbs are stretched out at full length upon the table. (Pl. IV. p. 9.)

SUPERFICIAL DISSECTION.

This dissection comprises the examination of the following parts :—

(1.) Superficial fascia.
(2.) Internal saphenous vein, and its several tributaries.
(3.) Arteries. { Superficial pudic. / Superficial epigastric. / Superficial circumflex iliac.
(4.) Lymphatic glands and vessels.
(5.) The saphenous opening.
(6.) Cutaneous nerves.
(7.) The fascia lata.
(8.) The bursa patellæ.

Reflection of Skin.—*Incisions.*—(1.) From the anterior superior spine of the ilium along the line of Poupart's ligament to the symphysis pubis. (2.) From the inner extremity of this line downwards, round the scrotum, and along the inner aspect of the thigh for four inches. (3.) From the lower extremity of this vertical incision transversely outwards, across the front of the thigh, to the outer aspect of the limb. (Pl. II., and Pl. IV. p. 9.)

The quadrilateral flap of skin thus traced out must be raised very carefully from the subjacent superficial fascia, and turned outwards.

Superficial Fascia.—It is usual for anatomists to complicate the description of this fascia by stating that it consists of two layers. We do not consider it necessary to make this subdivision. We look upon the superficial fascia in this region as being essentially the same as in all other localities of the body. We look upon it as being composed of one stratum of fatty areolar tissue—a stratum, however, which an expert dissector will have little difficulty in splitting up into two or more artificial layers.

The superficial fascia is firmly attached by its deep surface to the fascia lata below Poupart's ligament.* To demonstrate this attachment satisfactorily, it is necessary that the dissectors of the lower limb and abdomen should work in conjunction with each other. Supposing the skin to be reflected from the surface of the abdomen, a transverse incision should be made through the superficial fascia from the anterior superior spine of the ilium to the middle line of the body. On raising the lower edge of the divided fascia, the hand can be easily insinuated between it and the pearly-looking tendon of the external oblique, and it can be carried downwards under the fascia as

* According to Dr. Russell, who has made many special dissections of this fascia, the superficial fascia is attached to the deep fascia horizontally across the thigh. Internally it is attached to the inner half of Poupart's ligament, but the line of attachment falls below the outer half of the ligament which curves upwards.

far as Poupart's ligament. Here it will be found that the fingers can force their way no farther. The passage of the hand into the thigh is barred by the attachment of the deep surface of the superficial fascia to the fascia lata.

In the superficial fascia blood-vessels, glands, lymphatic vessels, and nerves are embedded, and these must now be dissected out.

Internal Saphenous Vein.—First look for this large vein. It will be found extending up the thigh a little way internal to the middle line of the limb. Trace it upwards till it reaches a point about two inches from Poupart's ligament. At this point it dips through the deep fascia, and joins the femoral vein. It is not desirable to define the opening in the fascia lata through which it passes, until a later stage of the dissection. Several tributaries join the internal saphenous vein at this point, and these should be dissected along with the small superficial arteries which accompany them. They are—(1.) The superficial pudic; (2.) The superficial epigastric; and (3.) The superficial circumflex iliac veins.

Arteries.—*The superficial pudic* will be found running upwards and inwards over the spermatic cord; *the superficial epigastric* courses upwards and leaves the thigh by crossing Poupart's ligament about its middle; *the superficial circumflex iliac* runs upwards and outwards along Poupart's ligament, to the anterior superior iliac spine. They are all branches of the femoral artery.

Lymphatic Glands and Vessels.—The large lymphatic glands in this region should next be dissected out from the fatty tissue in which they are embedded. In doing this take care to preserve as many of the minute ducts, which enter and leave the glands, as possible. A small artery and vein can be traced to each gland.

The disposition of the glands into two groups will now be evident,—an upper *inguinal* group along the line of Poupart's ligament, and a lower *femoral* group, which extends for a short way down the thigh along the line of the internal saphenous vein.

In a spare subject the general arrangement of the lymphatic ducts may also be made out. To the femoral group of glands proceed the ducts of the lower limb; to the inguinal glands go the ducts from the genitals, perinæum, and the surface of the abdomen. In addition to these numerous ducts pass between the various glands and connect them with each other.

Saphenous Opening.—This is the opening in the deep fascia through which the saphenous vein passes to effect its junction with the femoral vein. It requires an experienced dissector to display it in a satisfactory manner. Begin by removing the lymphatic glands. In doing this bear in mind that the *crural branch* of the genito-crural nerve pierces the fascia lata in the middle line of the thigh about an inch or so below Poupart's ligament. Take care also of the two divisions of the *middle cutaneous* nerve, which make their appearance in the same line about three inches below Poupart's ligament. A thin fascia, called the *cribriform fascia*, is spread over the opening and hides it from view. This fascia has received the name of "cribriform" because it is pierced by the saphena vein and by numerous lymphatic vessels. Some difference of opinion exists as to what this fascia really is. It is regarded by many as being a part of the superficial fascia, but it is more correct to look upon it as being a thin layer of fascia lata carried over the opening, or in other words a prolongation inwards of the outer margin of the opening.

To define the saphenous opening the dissector should commence by cautiously removing the superficial fascia from the fascia lata over the upper parts of the adductor longus and pectineus muscles. The deep fascia at this point is called the *pubic portion* of the fascia lata, and as it is cleaned, from within outwards, it will be observed to recede gradually from the surface and to be continued behind the femoral sheath. The clearly-defined inferior cornu of the saphenous opening will now be brought into view, curving under the internal saphenous vein, and blending with the *pubic fascia*. The *cribriform fascia* must now be removed so as to display the outer boundary of the opening. To a certain extent this dissection is artificial, seeing that the cribriform fascia is merely a continuation inwards of the outer lip of the opening. The outer boundary is usually very much broken up by the superficial branches of the femoral artery which pierce it, and its definition is a matter of some difficulty. In a spare subject, however, the line of demarcation between the *cribriform fascia* and the *iliac portion* of the fascia lata (this is the name given to that part of the fascia lata which lies external to the opening) may be readily made out. Take care not to injure the subjacent femoral sheath, and note how the superior cornu arches over the femoral vein to fuse with Gimbernat's ligament.

The oval shape of the opening is now apparent. Its inner boundary is seen to be exceedingly ill-defined, and to be formed by the receding *pubic portion* of the fascia lata; the crescentic outer boundary is seen to be formed by the *iliac portion* of the fascia lata. Lastly, bear in mind that the saphenous opening in the undissected state is closed in by the *cribriform portion* of the fascia lata.

Reflection of Skin.—The next step in the dissection consists in reflecting the skin from the lower two-thirds of the front of the thigh, and also from the anterior aspect of the knee. This is effected by extending the vertical incision, which has already been made upon the inner aspect of the thigh, downwards to the internal tuberosity of the tibia, and then carrying a transverse incision from the lower end of the vertical cut outwards over the front of the leg to its outer aspect. (Pl. II.) In raising the skin from the front of the knee take care not to injure the patellar plexus of nerves or the patellar bursa.

Cutaneous Nerves.—The cutaneous nerves are now to be looked for in the superficial fascia. They are six in number, and are derived from two sources. *Three* come from the *lumbar plexus*, and *three* are branches of the *anterior crural*:—

From lumbar plexus.	Ilio-inguinal. Crural branch of genito-crural. External cutaneous.
From anterior crural.	Middle cutaneous. Internal cutaneous. Long saphenous.

The *ilio-inguinal nerve* will be found as it escapes from the external abdominal ring in company with the spermatic cord. The *crural branch* of the genito-crural nerve pierces the fascia a little way below Poupart's ligament, and to the outer side of the femoral artery. With a little care a communication between this nerve and the middle cutaneous may be made out. The *external cutaneous* is found on the outer aspect of the thigh. It pierces the deep fascia in two parts. Of these, one—the *posterior* division—appears about two inches below the anterior superior iliac spine, and proceeds backwards and downwards. Some twigs of this nerve may be followed to the gluteal region. The *anterior* division comes to the surface about two inches lower down. It is the largest of the two, and has a wide area of distribution.

The *middle cutaneous nerve* pierces the fascia lata in the middle line of the thigh about three inches below Poupart's ligament. It usually appears as two nerves which perforate the fascia at two points. The *internal cutaneous* also divides into two before it reaches the superficial fascia. The *anterior* division makes its appearance in the lower part of the thigh near the internal saphenous vein. Follow it as it runs over the patella. The *inner* division reaches the surface on the inner side of the knee behind the long saphenous nerve. The *long saphenous nerve* becomes cutaneous on the inner side of the knee by perforating the fascia between the tendons of the sartorius and gracilis muscles. The guide to it is the superficial branch of the *anastomotic artery* which descends alongside of it. Before it pierces the fascia it gives off a *patellar* branch, which must also be secured.

All these cutaneous nerves must be carefully followed in their wide ramifications in the superficial fascia. Four nerves will be found to send twigs to the skin over the knee-joint—viz., the external cutaneous, the middle cutaneous, the anterior branch of the internal cutaneous, and the long saphenous. These nerves communicate with each other, and form the *patellar plexus.*

Fascia Lata.—This is the name which is given to that portion of the general aponeurotic investment of the lower limb which clothes the thigh. It should now be carefully cleaned by removing the remains of the superficial fascia. This being done, the dissector will be struck with the marked difference in strength which it shows at the outer and inner aspects of the thigh. Externally it is so dense and strong that it appears to be more tendinous than aponeurotic in its character. The reason of this is, that the tensor fasciæ femoris muscle and the greater portion of the gluteus maximus are inserted into it upon this side of the limb. The strong band thus formed goes under the name of the *ilio-tibial band*, from its being attached above to the crest of the ilium, and below to the outer tuberosity of the tibia. Internally, the fascia lata is so exceedingly delicate and thin that the subjacent muscular fibres shine through it, and it is very apt to be removed with the superficial fascia unless care be exercised in the dissection.

Patellar Bursa.—This is situated upon the superficial aspect of the patella. Pinch up the fascia lata as it passes over this bone with the forceps, and make a transverse incision through the wall of the sac, large enough to admit the finger. It will then be seen to extend downwards for a short distance upon the ligamentum patellæ. It is usually intersected by fibrous bands and cords.

DEEP DISSECTION.

In this dissection, the following parts require to be examined :—

(1.) The femoral sheath.
(2.) Crural branch of genito-crural nerve.
(3.) External cutaneous nerve.
(4.) Sartorius muscle.
(5.) Adductor longus muscle.
(6.) Anterior crural nerve and its branches.
(7.) Femoral vessels and their branches.
(8.) Psoas and iliacus internus muscles.
(9.) Quadriceps extensor. { Rectus femoris. Vastus internus. Crureus and subcrureus. Vastus externus. }

(10.) Tensor fasciæ femoris muscle.
(11.) Deep layer of the ilio-tibial band of fascia lata.
(12.) The external and internal intermuscular septa.
(13.) Pectineus muscle.
(14.) Gracilis muscle.
(15.) Adductor brevis muscle.
(16.) Obturator nerve.
(17.) Adductor magnus muscle.
(18.) Obturator externus muscle.
(19.) Obturator artery.

Femoral Sheath.—The exposure of the femoral sheath is the next step in the dissection of the thigh. To attain this object the *iliac portion* of the fascia lata must be partially reflected. Divide the superior horn of the outer crescentic margin of the saphenous opening, and then carry the knife outwards along the lower border of Poupart's ligament, so as to sever the attachment of the fascia lata to this thickened band. This incision should extend to within an inch of the anterior superior spine of the ilium. The piece of fascia marked out by the incision above, and by the outer free margin of the saphenous opening internally, must be carefully raised from the subjacent femoral sheath and thrown downwards and outwards. On the removal of a little loose fat, the *femoral sheath* will be brought into view as it enters the thigh under Poupart's ligament. Isolate it carefully from adjacent and surrounding parts, by carrying the handle of the knife gently round it,—insinuating it first between the sheath and *Poupart's ligament*, then between the sheath and *Gimbernat's ligament*, which lies internal to it, and lastly, between the sheath and the *pubic portion* of the fascia lata, which has been seen to recede behind it. Observe now the funnel-shaped appearance of the sheath—the wide mouth of the membranous tube pointing upwards into the abdomen, and the narrow inferior part gradually closing upon the vessels, and fusing with their coats about the level of the lower limit of the saphenous opening. If the dissection has been successfully performed, the *crural branch* of the *genito-crural* nerve should be seen piercing the outer wall of the sheath, and the internal saphenous vein, and some lymphatic vessels perforating its anterior and inner walls. Further, if the subject be spare, and the fasciæ well marked, the dissector will in all probability notice that the anterior wall of the sheath in its upper part is strengthened by some transverse fibres which pursue an arching course across it. To these fibres the name of *deep crural arch* is given, in contra-distinction to the term *superficial crural arch*, which is frequently applied to Poupart's ligament.

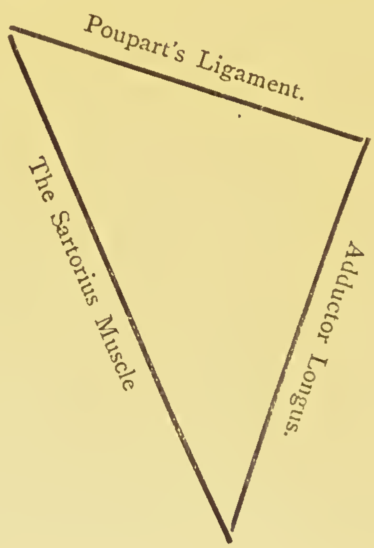
The femoral sheath should now be opened so as to see the arrangement of parts inside. Make three vertical and parallel incisions through the anterior wall—one over the artery, another over the vein, and the third about half-an-inch internal to the second. The first two should begin at the level of Poupart's ligament, and should extend downwards for an inch and a-half. The most internal of the three incisions should commence at the same point, but should only be carried downwards for half-an-inch. The sheath will now be seen to be subdivided by two vertical partitions into three compartments. The femoral artery occupies the *outermost* compartment; the femoral vein fills up the *middle* compartment; whilst in the *innermost* compartment is lodged a little loose areolar tissue, a small lymphatic gland, and some lymphatic vessels. This last compartment, from its relation to femoral hernia, has the special name of *crural canal* applied to it. Its boundaries and extent must be very thoroughly studied by the student. The best way to do this is to introduce the little finger into it and gently push it upwards. Its length is not nearly so great as that of the other two compartments. Indeed, its extent is rarely more than one inch. Its superior aperture is called the *crural ring*, and this is closed by the closely-applied extra-peritoneal fatty tissue. The parts which immediately surround this ring can be readily detected with the finger: externally the *femoral vein*, internally the sharp crescentic base of *Gimbernat's* ligament, anteriorly *Poupart's ligament*, and posteriorly the *pubic bone* covered by the *pectineus muscle*. That portion of the extra-peritoneal fat which closes the ring is called the *septum crurale*.*

Scarpa's Triangle.—This is the name which is given to the triangular hollow which lies below Poupart's ligament. To bring its boundaries into view the deep fascia must be removed from the anterior aspect of the upper third of the thigh. In the lower two-thirds the fascia lata should be left

* Should it so happen that the walls of the abdomen have been dissected, and the cavity of the abdomen opened into, the two dissectors should together examine the femoral sheath and crural canal from above.

undisturbed, so as to maintain the parts as far as possible in their natural position.

Boundaries.—The outer boundary is formed by the *sartorius* as it runs downwards and inwards across the thigh, from the anterior superior spine of the ilium, and the inner boundary is constituted by the prominent internal margin of the *adductor longus.* Clean these muscles down to the point where they meet to form the apex of the triangle.



Poupart's ligament is the base of the triangle.

Contents.—The contents of the space must now be displayed by removing the fatty areolar tissue which surrounds them. The *femoral vessels* should first be cleaned. Remove the remains of the femoral sheath and define the various branches which proceed from the vessels in so far as they are seen within the limits of the triangular space. Be very careful not to injure the small nerve which springs from the anterior crural and passes inwards behind the vessels to supply the pectineus muscle. In this part of its course the femoral artery gives off—(1.) The *three superficial inguinal* vessels, which have already been observed ramifying in the superficial fascia of the groin ; (2.) The *inferior external pudic*, which runs inwards over the pectineus ; (3.) The large *profunda femoris.*

The *profunda femoris* comes off from the outer side of the femoral artery about one and a-half inches below Poupart's ligament. It soon leaves the space by passing under cover of the adductor longus. The *external* and *internal circumflex* arteries will be seen to arise from the profunda within Scarpa's triangle.

The *external circumflex* should be traced outwards as it passes amongst the branches of the anterior crural nerve to disappear under cover of the outer boundary of the space. The *internal circumflex* is lost to view shortly after its origin by sinking backwards between the pectineus and psoas muscles. The veins corresponding to these arteries must be cleaned along with them.

But certain nerves are also to be found in this space —viz., (1.) the *external cutaneous ;* (2.) and the *anterior crural.* The *external cutaneous* will be found passing into the thigh under Poupart's ligament close to the anterior superior spine of the ilium. It soon leaves the triangle by piercing the fascia lata, and it has already been traced in its ramifications in the superficial fascia on the outer aspect of the thigh. The *anterior crural nerve* will be detected lying deeply in the interval between the psoas and iliacus muscles, about a quarter of an inch to the outer side of the femoral artery.

Insinuate the handle of a knife under the main trunk so as to raise it above the level of the muscles between which it lies, and render it tense, and then follow the numerous branches into which it breaks up as far as the limits of the space will allow. The minute twig to the pectineus muscle must be looked for with especial care. It passes inwards behind the femoral vessels and sinks into the superficial surface of the muscle.

Floor.—The floor of Scarpa's triangle is peculiar because it slopes backwards both from the inner and outer boundary of the space. To the inner side of the femoral artery it is formed by the *adductor longus* and *pectineus*, and between these by a small portion of the *adductor brevis;* to the outer side of the artery are the *psoas* and *iliacus.* The adductor longus is placed at an oblique plane, the inner border being nearer the surface than the outer border; and thus it is that it not only forms the inner boundary of the triangle but also takes part in the formation of the floor. These muscles should be cleaned in so far as they stand in relation to Scarpa's triangle.

The fascia lata may now be removed from the lower two-thirds of the thigh. This can best be effected by dividing it along the middle line of the limb and throwing it outwards and inwards. Preserve undisturbed the thickened band of fascia which lies upon the outer aspect of the thigh, and in raising the inner part from the surface of the sartorius be careful of certain nerves which lie in close relation to the inner margin of the muscle.

Anterior Crural Nerve.—The branches of this nerve should first engage the attention of the dissector. It will be noticed that they resolve themselves into a *cutaneous* and *muscular* series. The *cutaneous* branches are (*a*) the *middle cutaneous*, (*b*) the *internal cutaneous*, and (*c*) the *long saphenous*. Be careful of the minute twigs of supply which enter the sartorius from the first two of these nerves. Trace the *internal cutaneous* downwards to the point at which it splits into its *anterior* and *inner* divisions. The latter will be noticed to run along the inner margin of the sartorius, and especial care must be exercised in its dissection, because by tracing out its various branches a delicate plexus may be made out, in the formation of which filaments from the long saphenous and obturator nerves also take part. The *long saphenous* runs along the outer side of the femoral artery.

The *muscular* branches of the anterior crural are distributed to the extensor muscles, and they must be traced into the muscles which they supply. The small twig to the pectineus has already been noted. It usually springs from the anterior crural at a point corresponding to the origin of the profunda femoris artery. The nerves to the vastus externus and internus have a special interest, inasmuch as each sends a delicate filament to the knee-joint. These twigs descend amidst the muscular fibres, and each is associated with an artery—the internal with the articular branch of the *anastomotic* artery, and the external with the descending branch of the *external circumflex* artery.

Femoral Vessels — Sartorius Muscle. — The sartorius should now be cleaned throughout its whole extent and then drawn aside, so that we may be able to trace the femoral vessels in their course down the thigh. Note the deep recess in which they lie—a recess bounded by the adductor muscles on the inside and by the vastus internus upon the outside. Observe further how this is converted into a triangular canal by a strong fibrous membrane which stretches across it. The tunnel thus formed is *Hunter's canal.* Examine carefully the fibrous expan-

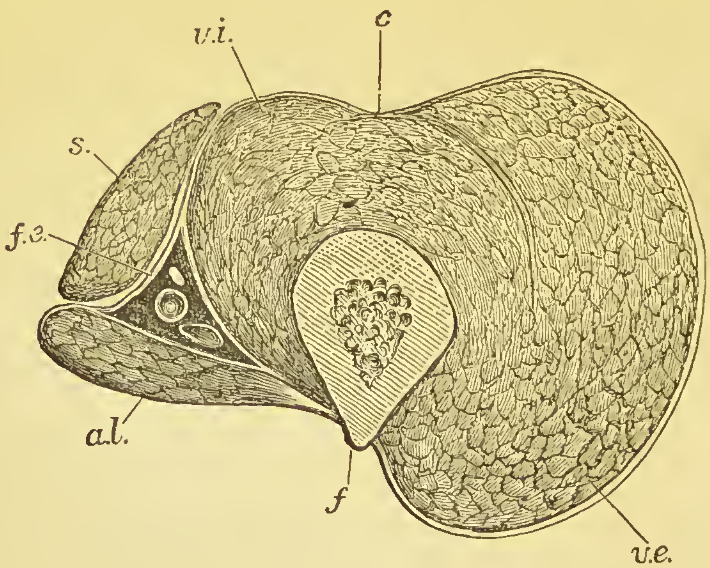


FIG. 5.

Transverse section through Hunter's Canal to show its triangular form, its boundaries, and its contents. *f*, The femur transversely divided; *v.i.*, Vastus internus; *c*, Crureus; *v.e.*, Vastus externus; *s.*, Sartorius; *f.e.*, Fibrous expansion stretching between the vastus internus and the adductor longus; *a.l.*, Adductor longus. The femoral artery, the femoral vein, and the long saphenous nerve are seen occupying the canal. At the point of section the nerve lies in front and slightly to the outside of the artery; the vein lies behind and slightly to the outside of the artery.

sion which closes in the canal anteriorly. Trace it upwards and it will be seen to become thin and ill-defined; follow it downwards and it becomes dense, and ends abruptly in a sharply-defined margin opposite the opening in the adductor magnus. At this point look for the long saphenous nerve and the superficial branch of the anastomotic artery. They will be found escaping from the canal by passing under cover of the lower free border of the expansion. Divide this aponeurotic expansion in order that we may bring into view the contents of the canal. These are—(1.) The femoral artery; (2.) The femoral vein; and (3.) The long saphenous nerve. While the artery lies in Hunter's canal it gives off the *anastomotica magna.* The *deep* branch of this artery sinks into the substance of the vastus internus, and may be traced through its fibres to the knee-joint. The *superficial* branch, with the long saphenous nerve, escapes at the lower end of the canal, and becomes superficial at the inner side of the knee. The various *muscular* branches of the femoral artery must also be preserved.

Tensor Fasciæ Femoris and Ilio-tibial Band of Fascia Lata.—The tensor fasciæ femoris will be seen in the upper and outer part of the thigh. The dissector should carefully study its peculiar relation to the fascia lata. Separating the *ilio-tibial* band of the fascia lata from the outer surface of the vastus externus, to which it is connected by some loose areolar tissue, and tracing it upwards, it will be observed to split into two layers—a superficial and a deep—so as to enclose the muscle. Both layers are exceedingly strong, and the tensor fasciæ femoris is inserted into the angle of splitting. The superficial lamina is attached above to the crest of the ilium ; the deep layer can be followed upwards to the capsule of the hip-joint, with the upper and outer part of which it blends. This layer is perforated by the ascending twigs of the external circumflex artery. Now turn the muscle outwards so as to display its deep surface. A little dissection will bring into view its nerve of supply, which comes from the *superior gluteal.* A few arterial twigs from the external circumflex also sink into its substance at this point.

External Circumflex Artery.—The branches of this vessel must now be followed to their terminations. Three sets of branches can be distinguished :—(*a.*) *Ascending*, which reach the dorsum ilii by passing under cover of the tensor fasciæ femoris. There they anastomose with the *gluteal* artery. (*b.*) *Descending*, which run downwards. Of these one long branch may be traced downwards amid the fibres of the vastus externus to the knee, where it anastomoses with the *superior external articular* artery. (*c.*) *Transverse*, of very small size, which penetrate the substance of the vastus externus to reach the back of the thigh, and there anastomose with the *internal circumflex* and *first perforating arteries.*

Quadriceps Extensor Muscle and the Intermuscular Septa.—Divide the *ilio-tibial* band of fascia lata below the point at which it splits to enclose the tensor fasciæ femoris. We do this so as to obtain a better view of the vastus externus, and in order that we may demonstrate satisfactorily of the external intermuscular septum. Take hold of the lower portion of the ilio-tibial band and draw it forcibly outwards; at the same time push inwards the vastus externus muscle, and a strong fibrous septum will be seen passing inwards from the fascia lata towards the linea aspera. This is the *external intermuscular septum* of the thigh, a partition interposed between the vastus externus and the short head of the biceps. Follow it upwards and downwards with the finger. The fibres of the vastus externus are seen arising from it, but little difficulty will be experienced in making out its

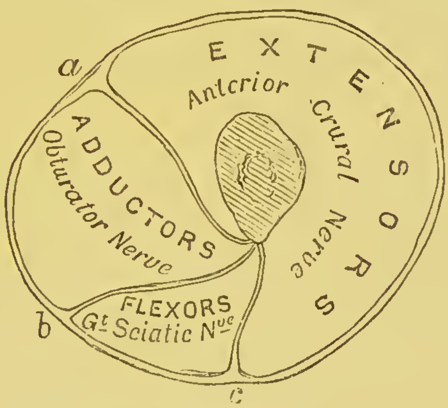


FIG. 6.

Diagram to show how the thigh is subdivided into three compartments by its general aponeurotic investment and the three intermuscular septa which pass inwards from it to the linea aspera of the femur. *a*, Interna intermuscular septum; *c*, external intermuscular septum; *b*, the third septum which is interposed between the adductor muscles and the flexor muscles. Each compartment contains its own group of muscles, and with each group a particular nerve is associated.—(*After* Professor TURNER).

attachment to the linea aspera of the femur. Immediately above the external condyle of the femur it is pierced by the *superior external articular* vessels. The *internal intermuscular septum* is interposed between the adductors and the vastus internus, and should also be examined. It is thin in comparison with the external septum.

Now clean the *rectus* and expose its two heads of origin by dissecting deeply in the interval between the iliacus and the tensor fasciæ femoris. Observe how completely the other three factors of the quadriceps muscle clothe the shaft of the femur on its inner, outer, and anterior aspects. The *crureus* and *vastus internus* are usually described as being inseparably united. This is a mistake. It is true that the anterior fleshy margin of the vastus internus is commonly blended with the *crureus* in its upper two-thirds, but a separation can be readily effected. The muscle can then be thrown inwards. When this is done the entire inner surface of the shaft of the femur is left bare.*

* In a recent article upon the Quadriceps Extensor Cruris Muscle, by W. Rogers Williams (*Journ. Anal. and Phys.*, Vol. XIII.), the following directions are given for separating the vastus internus from the crureus :—"A line drawn from the tubercle at the middle of the spiral or inter-trochanteric line, inclining downwards and slightly outwards to the middle of the upper border of the patella, will define accurately the thick anterior border of the vastus internus. . . . To detach the muscle, we must first free the anterior edge. It is best to *begin below*, just above the patella, for here the tendinous under-surface of the vastus internus rests upon the aponeurosis of the crureus, and the two are readily separable. The fleshy part of this border is commonly blended with the crureus, and to free it muscular fibres must be cut through. But it often happens, even at this place, that the two muscles are simply contiguous without being fused ; in these cases a complete separation is easily effected without any division of fleshy fibres."

The fleshy mass of the vastus internus may now with advantage be divided transversely about two or three inches above the patella. The muscle can then be thrown inwards and its origin studied. The internal surface of the femur is left bare. Mr. Williams gives an additional guide for separating the vastus internus from the crureus :—"Running along the edge of the crureus, for its lower three-fourths, behind the line of union of this muscle with the vastus internus ; is a long slender nerve, derived from the upper branch to the vastus internus ; it is distributed to the *subcrureus* and to the *upper part of the synovial pouch of the knee-joint.*"

The *vastus externus* can be partially separated from the crureus, and the line of separation is indicated by the descending branch of the external circumflex artery, and the nerve of supply to the muscle.

The *subcrureus muscle* is simply a part of the crureus. It consists of a bundle of muscular fibres inserted into the synovial membrane. It is displayed by the dissection which has been made to separate the vastus internus from the crureus. Its nerve of supply has been noted.

Adductor Muscles.—The group of adductor muscles on the inner aspect of the thigh, together with the nerves and blood-vessels associated with them, must next be dissected. These muscles are disposed in three strata: the superficial stratum being formed by the adductor longus and the pectineus, which lie in the same plane; the second stratum being represented by the adductor brevis; and the third or deep stratum by the adductor magnus. The gracilis muscle, also an adductor, extends along the inner aspect of the thigh. Interposed between these muscular layers, and affording a means of separating the one from the other (even in animals where they are more or less fused), are the two divisions of the *obturator nerve*. The *anterior* division is placed between the superficial and middle layers, and the *posterior* division between the middle and deep layers. The *profunda artery* also lies for a part of its course between the superficial and middle strata.

Adductor Longus and Profunda Artery.—The adductor longus should be reflected after the dissector has satisfied himself regarding its precise bony attachments. Divide it close to the round tendon of origin and throw it outwards. In doing this be careful of the anterior division of the obturator nerve, which lies under cover of it, and sends to it its nerve-supply. On approaching the linea aspera it will be found that its tendon is more or less fused with those of the adductor brevis and magnus. Separate them as far as possible, in order that we may obtain a good view of the profunda vessels.

A little dissection will show the *profunda artery* and *vein* lying upon the adductors brevis and magnus, and separated from the femoral vessels by the interposition of the adductor longus. The *perforating arteries* will be seen to arise in series from the main trunk. The *first* of these arises at the lower margin of the pectineus, and pierces both the adductor brevis and adductor magnus. The *second* will be found a little lower down, and it perforates the same muscles. Endeavour to find a small *nutrient* artery to the femur which springs from this branch. The *third* and the *terminal twig* of the artery pierce the adductor magnus alone.

Pectineus and Internal Circumflex Artery.—The pectineus muscle must in the next place be reflected from its origin and thrown outwards. In separating the muscle from the pubis the dissector must remember that in some cases an *accessory obturator* nerve descends into the thigh over the brim of the pelvis and under cover of the pectineus.

The *internal circumflex* branch of the profunda may now be followed backwards. It arises at the upper border of the pectineus and passes back between this muscle and the psoas, then between the adductor brevis and obturator externus, and it appears in the gluteal region in the interval between the adductor magnus and quadratus femoris.

In every region of the thigh the dissector has met with branches of the femoral artery. It is well now that he should revert to this vessel and study its branches systematically. The following Table may aid him in doing this :—

- Femoral.
  - Superficial inguinal.
    - Superficial pudic.
    - Superficial epigastric.
    - Superficial circumflex iliac.
  - Inferior external pudic.
  - Profunda or deep femoral.
    - External circumflex.
    - Internal circumflex.
    - First perforating.
    - Second perforating.
      - Nutrient.
    - Third perforating.
    - Fourth perforating, or terminal.
  - Muscular.
  - Anastomotica magna.

Adductor Brevis and Obturator Nerve.—The adductor brevis muscle should be examined in its relation to this nerve. The *anterior* portion of the nerve lies upon its superficial surface and dispenses branches to four muscles, viz.—(1.) adductor longus ; (2.) adductor brevis ; (3.) gracilis ; (4.) and sometimes the pectineus. In addition to these it gives a filament to the plexus of nerves which lies along the inner margin of the sartorius, and a delicate branch may be traced to the coats of the femoral artery.

Having followed these nerves to their various destinations, the dissector may clean and then reflect the adductor brevis. This will bring into view the *posterior division* of the obturator nerve lying upon the surface of the adductor magnus. It is chiefly expended in the supply of this muscle, but it also gives filaments to the obturator externus and a delicate twig to the knee-joint. This latter branch pierces the lower fibres of the adductor magnus, and has already been seen in the popliteal space lying upon the popliteal artery.

Adductor Magnus and Gracilis.—These muscles should now be cleaned and examined. In the case of the adductor magnus the tendinous arches formed for the passage of the perforating arteries and the large opening for the transmission of the femoral artery deserve the special attention of the student. The adductor magnus should now be detached from the innominate bone, in order that we may obtain a more satisfactory view of the obturator externus muscle and some small branches from the obturator artery.

Obturator Externus — Obturator Artery — Psoas and Iliacus.—Clean the *obturator externus* and note its position in relation to the hip-joint. As it winds behind the neck of the femur to reach the digital fossa, it lies in relation to the inferior aspect of the capsular ligament. The *obturator artery* belongs to the dissector of the abdomen, but it is of interest to the dissector of the lower limb inasmuch as twigs from it come under his notice at two different points—(1.) In the present dissection, appearing in relation to the obturator externus and anastomosing with the internal circumflex; (2.) In the gluteal region in the interval between the quadratus femoris and inferior gemellus.

The *psoas* and *iliacus* must next be studied and their insertion defined.

Removal of the Limb from the Trunk.—The limb should now be removed from the trunk. This dissection involves the study of the hip-joint. The steps by which it may be effected are the following:—Begin by dividing the femoral vessels and the anterior crural nerve about an inch below Poupart's ligament, and having tied them together with twine throw them downwards. Now cut through the sartorius and rectus femoris about two inches from their origin and turn them aside. The common tendon of the psoas and iliacus must next be severed a short way above its insertion and the two muscles raised from the anterior aspect of the capsule of the hip-joint. In doing this an intervening bursal sac will be displayed. Open this and ascertain its extent by introducing the finger. In some cases it may be found to be directly continuous with the synovial membrane of the hip-joint through an aperture in the capsular ligament.

The *capsular ligament* should now be carefully studied, not only in regard to its attachments, the disposition of its fibres, and its relative strength at different points, but also in regard to the various parts which surround it. Manipulate the limb and note the effect which the different movements have upon the different parts of the capsule. The attachment of the deep layer of the ilio-tibial band of fascia lata to the capsule can now be demonstrated, and it should be observed that this lamina of fascia is rendered very tense when the limb is slightly abducted and rotated outwards and the thigh slightly flexed.

Reflect the tensor fasciæ femoris and divide the capsular ligament first in front and then behind the joint. The head of the femur can now be withdrawn from the acetabulum, and by cutting through the ligamentum teres and the obturator externus muscle the limb can be removed from the trunk. Before doing this, however, the student should carefully study the anatomy of the joint.

The limb should now be carried to one of those tables which are set aside for the dissection of separate parts, and after the student has again identified the several muscles of the thigh and studied their attachments, he should cut away the great bulk of them, leaving only a small portion of each where it is attached to the bone. The vastus externus and crureus, however, should be retained intact.

In the dissection of the leg the student should recognise four regions, viz. :—

(1.) *An Anterior tibio-fibular region*,—which embraces those structures which lie in front of the interosseous membrane, and between the two bones of the leg.

(2.) *A tibial region*,—corresponding with the subcutaneous or inner surface of the tibia.
(3.) *A peroneal region*,—which includes the parts in relation to the outer surface of the fibula.
(4.) *A posterior tibio-fibular region*,—or the parts on the back of the leg which lie behind the interosseous membrane and the two bones of the leg.

The anterior tibio-fibular region should be dissected first, and it is usual to conjoin with this the dissection of the dorsum of the foot.

ANTERIOR TIBIO-FIBULAR REGION—DORSUM OF FOOT.

In this dissection the dissector is required to examine the following parts :—

(1.) Superficial veins.
(2.) Cutaneous nerves.
(3.) Deep fascia and its intermuscular septa.
(4.) Tibialis anticus.
(5.) Extensor longus digitorum.
(6.) Peroneus tertius.
(7.) Extensor longus hallucis.
(8.) Anterior tibial vessels.
(9.) Anterior peroneal artery.
(10.) Anterior tibial nerve.
(11.) Recurrent articular branch from the external popliteal nerve.
(12.) Extensor brevis digitorum.
(13.) Dorsalis pedis artery.

The limb should be placed in a convenient position for the dissection of this region. A block should be introduced beneath the knee, and the foot should be extended and fastened firmly to the table by means of hooks.

Reflection of Skin.—The skin should be reflected from the *tibial* and *peroneal* regions at the same time. *Incisions*:—(1.) A vertical cut along the middle line of the leg and dorsum of the foot to the base of the middle toe; (2.) A transverse incision across the ankle-joint; (3.) A transverse incision across the dorsum of the foot at the roots of the toes.

The four flaps of skin thus mapped out must now be raised from the subjacent fatty tissue, and the superficial veins and nerves dissected out.

Superficial Veins.—The *venous arch* on the dorsum of the foot, which receives the digital veins, should in the first place be dissected. From the inner extremity of this arch the *internal saphenous* vein will be seen to take origin, whilst from its outer end the *external saphenous* vein proceeds. Trace these vessels upwards. The former will be found to pass in front of the internal malleolus, whilst the latter ascends behind the external malleolus. Each is associated with the nerve which bears its own name.

Cutaneous Nerves.—The following are the cutaneous nerves which must be secured in this dissection:—

(1.) Branches from the external popliteal.
(2.) External saphenous.
(3.) Internal saphenous.
(4.) Musculo-cutaneous.
(5.) Anterior tibial.

The *twigs* from the *external popliteal* are very minute, and are distributed upon the outer aspect of the leg in its upper part. The *external saphenous* nerve can be readily found. It reaches the outer margin of the foot by passing behind the external malleolus in company with the vein of the same name. Trace it forwards, and it will be found to end upon the fibular side of the little toe. The *internal saphenous* nerve should be looked for in front of the inner maleolus. It descends in company with the internal saphenous vein. It can with care be followed half-way along the inner margin of the foot, but here it ends. Above the ankle-joint several minute twigs from this nerve may be found passing forwards to reach the front of the leg.

The *cutaneous portion* of the *musculo-cutaneous* nerve appears in the lower third of the leg. It pierces the deep fascia a short way to the outside of the middle line of the limb. On following it downwards it will be observed to split into an *inner* and an *outer* part. The *inner* division should be traced out first. It goes to the tibial side of the great toe. It gives a number of twigs to the skin upon the inner margin of the foot and effects a junction with the anterior tibial and internal saphenous nerves. The *outer* part will be noticed to divide into a number of branches, and on following these forward they will be found to supply twigs to the fibular side of the second toe, both sides of the third and fourth toes, and the tibial side of the fifth toe.

The *anterior tibial* pierces the deep fascia on the dorsum of the foot in the interval between the first and second metatarsal bones. It ends by dividing into two twigs, which go to supply the adjacent margins of the great toe and the second toe.

Deep Fascia.—The fatty superficial fascia must now be removed, so that the dissector may obtain a view of the deep fascia. It is convenient to study it in the peroneal region at the same time. The deep fascia is not equally dense throughout. Note its great strength in its upper part, and how it thins lower down. On the dorsum of the foot it is so exceedingly fine that it can scarcely be said to exist. The reason of its great strength in the upper part of the leg is readily explained. At this point it gives origin to subjacent muscles, and here also it receives fibres from a number of the tendons in relation to the knee-joint—viz., from the vasti anteriorly, from the biceps externally, and from the expanded tendons of the sartorius, gracilis, and semitendinosus internally. As it passes over the ankle-joint it forms two thickened bands in front of the joint, and a third upon the outer aspect of the joint. These are the *anterior* and *external annular* ligaments.

The *anterior annular ligament* will be observed to consist of an *upper* and a *lower* part. The former stretches between the tibia and fibula immediately above the ankle-joint. The *lower portion* is attached externally to the outer surface of the os calcis and internally to the internal malleolus and plantar fascia. Its outer attachment is narrow and strong; its inner end is expanded and weak.

The *external annular ligament* is short and narrow, and bridges over the hollow between the external malleolus and the os calcis.

The deep fascia must now be removed, but the annular ligaments should be retained and their borders defined by the knife. In the upper part of the le· it will be found impossible to separate the fascia from the subjacent muscles. At a lower level it can be readily raised, and this should be effected by dividing it longitudinally along the middle line. As we

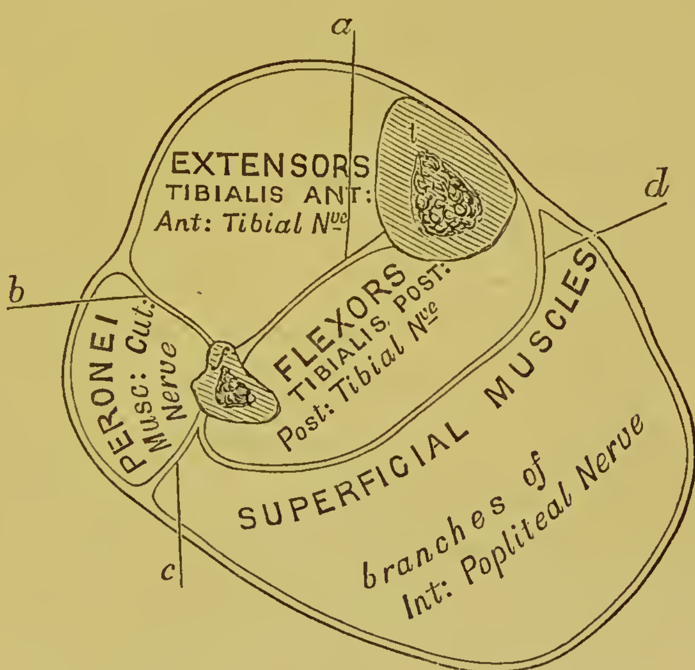


FIG. 7.

Diagram to show the osteo-fascial compartments of the leg. *t*, Tibia ; *f*, Fibula, both of which are seen in transverse section. The general aponeurotic covering of the leg is represented fusing with the periosteum over the subcutaneous or inner surface of the tibia ; *a*, Interosseous membrane ; *b*, The intermuscular septum which intervenes between the peroneal muscles and the extensor longus digitorum ; *c*, The septum between the peroneal muscles and the flexor longus hallucis and soleus. The three osteo-fascial compartments are mapped out and their contents indicated. The posterior compartment is subdivided into two parts by the deep layer of fascia, *d* ; as is usual in the case of muscles contained within such compartments, each group has its own distinctive nerve-supply.

dissect it inwards, its firm attachment to the anterior border of the tibia will be noticed. Externally it is continued round the limb to the back of the leg. But as we turn it outwards two strong intermuscular septa will be demonstrated passing towards the fibula, to which they are attached. Of these one is interposed between the peroneal muscles and the extensor longus digitorum (Fig. 7, *b*), whilst the other is placed between the peroneal muscles and the flexor longus hallucis and soleus muscles (Fig. 7, *c*). Three osteo-fascial compartments are thus formed, and within these are enclosed the structures in the *anterior tibio-fibular*, *peroneal*, and *posterior tibio-fibular* regions respectively.

Muscles.—The muscles on the front of the leg and the *extensor brevis digitorum* on the dorsum of the foot should now be cleaned and defined. The *tibialis anticus* lies in relation to the tibia ; the *extensor longus digitorum* is placed along the fibula ; and, on separating these two muscles from each other, the *extensor longus hallucis* will be observed lying between them in the lower half of the leg. The *peroneus tertius* is simply the lower portion of the extensor longus digitorum. It is in most cases inseparably blended with it at its origin.

In the upper third of the leg a strong intermuscular septum from the deep fascia will be seen to dip backwards between the tibialis anticus and the extensor longus digitorum, and to afford a surface of origin to both. The two muscles should be separated from each other along the plane of this septum.

The tendons of these muscles should now be followed downwards through their respective compartments in the anterior annular ligament to the dorsum of the foot. Here they will be found to diverge so as to reach their various points of insertion—the tendon of the tibialis anticus inclining inwards so as to be inserted into the plantar aspect of the internal cuneiform bone and the base of the first metatarsal; the tendon of the extensor longus hallucis running towards the hallux, into the terminal phalanx of which it is inserted; the four tendons of the extensor passing one to each of the four outer toes; and the tendon of the peroneus tertius inclining outwards so as to reach its insertion into the upper surface of the base of the fifth metatarsal bone. Notice also the manner in which the tendons of the extensor brevis digitorum are inserted. They go to the four inner toes; the innermost is inserted into the base of the first phalanx of the great toe, and the other three join the corresponding tendons of the extensor longus digitorum.

The expansion formed by the tendons of the extensor longus digitorum upon the dorsum of the first phalanx of each of the four outer toes should be examined and preserved. In a subsequent dissection the interossei muscles and the lumbrical muscles will be found to be inserted into its borders. This expansion as we trace it forwards will be found to be marked off into three pronounced slips. The middle slip is inserted into the base of the middle phalanx and the two lateral slips continue onwards, and are inserted into the ungual phalanx.

Anterior Tibial Artery.—The anterior tibial vessels should now be studied. They come from the posterior aspect of the leg. The *anterior tibial* artery is one of the two terminal branches of the popliteal, and it gains the front of the leg by passing forwards through the opening in the upper part of the interosseous membrane. It is an exceedingly difficult vessel to display owing to the close manner in which it is embraced by its two *venæ comites* and the short transverse communicating veins which pass between these both in front and behind the artery. It is not necessary, however, to preserve these small transverse veins. Observe the great depth at which the anterior tibial artery is placed in the upper part of the leg. Here it lies upon the interosseous membrane between the tibialis anticus and extensor longus digitorum in the first instance, but afterwards between the tibialis anticus and extensor longus hallucis. As the fleshy bellies of the muscles give place to the tendons which spring from them, the artery will be seen to become more superficial and to lie upon the tibia. Immediately above the ankle-joint it is crossed by the tendon of the extensor longus hallucis, and now passing under cover of the anterior annular ligament it enters the dorsum of the foot, and receives the name of *arteria dorsalis pedis.* The anterior tibial nerve will be noticed to lie in close relation to the artery throughout its whole course in the leg, and, in cleaning the vessel and its branches, care must be taken of the twigs which are given by this nerve to the neighbouring muscles.

The anterior tibial artery gives off the following branches :—

(1.) Numerous muscular branches.

(2.) Recurrent tibial.
(3.) External malleolar.
(4.) Internal malleolar.

The *recurrent tibial* comes off as soon as the parent trunk reaches the front of the leg. It passes upwards through the fibres of the tibialis anticus to reach the anterior aspect of the knee-joint. The *malleolar* are given off close to the ankle-joint. The *external* passes outwards under cover of the tendons of the extensor longus digitorum and peroneus tertius, whilst the *internal* runs inwards under cover of the tendons of the extensor longus hallucis and tibialis anticus.

Anterior Tibial Nerve.—This nerve, a branch of the external popliteal nerve, has already been seen in relation to the anterior tibial artery. Its various branches to the muscles on the front of the leg should be cleaned. It gives branches (1.) to the tibialis anticus, (2.) to the extensor longus hallucis, (3.) to the extensor longus digitorum, and (4.) to the peroneus tertius. You will notice that it reaches the anterior tibial artery by emerging from amongst the fibres of the extensor longus digitorum, in the upper part of the leg; further, that it leaves the leg by passing along with the artery under cover of the anterior annular ligament.

Anterior Peroneal Artery.—In a successfully injected subject this vessel will be exposed, as it runs downwards upon the lower part of the fibula, by drawing aside the peroneus tertius muscle. A little dissection will show that it reaches the front of the leg by piercing the interosseous membrane about two inches above the outer malleolus. Follow it downwards to its distribution on the outer aspect of the ankle-joint. It is the anterior or perforating terminal twig of the peroneal branch of the posterior tibial artery.

Dorsalis Pedis Artery—Anterior Tibial Nerve on the Dorsum of Foot.—The *arteria dorsalis pedis* should now be followed as it runs forwards upon the dorsum of the foot. At the posterior part of the first interosseous space it will be seen to dip downwards between the heads of the first dorsal interosseous muscle, so as to gain the sole of the foot. A short way behind this point the innermost tendon of the extensor brevis digitorum crosses it. Observe how it lies in relation to the other tendons on the dorsum of the foot. To its inner side is the tendon of the extensor longus hallucis; to its outer side is a tendon of the extensor longus digitorum. It gives off three branches :—(1.) the *tarsal*, (2.) the *metatarsal*, and (3.) *dorsalis hallucis*.

The *tarsal* artery arises opposite the scaphoid bone and the *metatarsal* branch a little further forwards. They both run outwards under cover of the extensor brevis digitorum to reach the outer margin of the foot. From the arch which is formed by the metatarsal artery *three interosseous* arteries proceed—one to each of the three outer interosseous spaces. The *dorsalis hallucis* artery springs from the dorsalis pedis just before it disappears from view, and it runs forwards in the innermost interosseous space.

The *anterior tibial* nerve lies to the outer side of the dorsalis pedis artery. It has already been seen to become superficial in the first interosseous space and supply the contiguous sides of the hallux and second toe. Before it pierces the fascia it gives off a large branch which passes outwards under cover of the extensor brevis digitorum, to which it gives branches, and swelling out in a gangliform manner, it ends in twigs to the articulations of the foot. It likewise, in many cases, supplies delicate twigs to the first and second dorsal interosseous muscles.

Anterior Annular Ligament.—The dissector should again examine this ligament and the arrangement of the structures which pass under it, seeing that all these are now fully dissected. The *upper portion* is attached to the fibula by its outer end, and to the tibia by its inner extremity. By dividing its fibular attachment and throwing it inwards, it will be seen to give a separate and distinct sheath to the tibialis anticus.

The lower portion is the more important of the two. Its attachments have already been noted. Examine closely the manner in which it holds the tendons in their place. It consists of two layers, and these, by separating at certain points and becoming reunited at others, form three distinct sheaths. Through the *innermost* passes the tendon of the tibialis anticus; through the *middle* one passes the tendon of the extensor longus hallucis; and through the *outermost* are transmitted the tendons of the extensor longus digitorum and peroneus tertius. On opening up these sheaths they will be seen to be lined by synovial membrane. Lastly, note the position of the anterior tibial vessels and nerve as they pass under cover of the ligament. They lie between the extensor longus hallucis and the extensor longus digitorum.

PERONEAL REGION.

In this region are comprised :—

(1.) The peronei muscles.
(2.) The external popliteal nerve.
(3.) The musculo-cutaneous nerve.

Peronei Muscles.—The *peroneus longus* and *brevis* lie upon the outer aspect of the fibula, and their tendons should be followed downwards under cover of the external annular ligament to the outer margin of the foot. The insertion of the peroneus brevis into the projection of the base of the fifth metatarsal can now be made out, but the tendon of the peroneus longus disappears by passing into the sole in the groove on the under surface of the cuboid bone. Note the relation which these two tendons have to each other as they lie behind the outer malleolus. The peroneus longus lies upon the peroneus brevis, and both are enveloped by a synovial membrane.

External Popliteal Nerve—Musculo-Cutaneous Nerve.—The external popliteal nerve has already been traced as far as the neck of the fibula. The student will now see that it disappears from view at this point by passing between the peroneus longus and the bone. This muscle must therefore be carefully turned aside from its origin in order that the nerve may be followed out. It will be found to give off a small *recurrent articular* nerve to the knee-joint, and then to divide into the *anterior tibial* and *musculo-cutaneous nerves.*

The *recurrent* branch accompanies the recurrent tibial artery. The *anterior tibial* pierces the upper part of the extensor longus digitorum to reach the front of the leg. The *musculo-cutaneous* should be traced downwards in the substance of the peroneus longus. It then reaches the interval between the two peronei muscles, which it supplies, and lastly it comes to lie between the peroneus brevis and the extensor longus digitorum. It becomes cutaneous in the lower third of the leg where it has been seen piercing the fascia.

TIBIAL REGION.

This region corresponds to the subcutaneous or inner surface of the tibia. The deep fascia blends with the periosteum of the bone, and the only structures which have to be examined are :—

(1.) The internal saphenous vein.
(2.) The internal saphenous nerve.
(3.) The expanded tendons of insertion of the sartorius, semitendinosus, and gracilis.
(4.) Internal lateral ligament of knee-joint.
(5.) Inferior internal articular artery and nerve.

The internal saphenous nerve and vein are found ascending obliquely over the lower third of the inner surface of the tibia as they pass from the anterior to the posterior tibio-fibular region.

The insertion of the *sartorius*, *gracilis*, and *semitendinosus* into the upper part of the inner surface of the tibia should again be examined. Observe how the sartorius overlaps the tendons of the other two, and how the tendon of the gracilis overlaps the upper part of the tendon of the semitendinosus. Synovial bursæ separate these tendons from each other.

The *internal lateral ligament* of the knee-joint will be seen extending downwards for a short distance upon the inner aspect of the shaft of the tibia. Passing forwards under cover of this ligament, so as to gain the anterior aspect of the knee, are the *inferior internal articular vessels* and nerve.

POSTERIOR TIBIO-FIBULAR REGION.

BACK OF THE LEG.

The limb must now be placed on its anterior aspect, and the muscles of the calf rendered tense by flexing the foot at the ankle-joint. This position should be maintained by the aid of hooks, fastened on the one hand to the toes and on the other hand to the under surface of the table.

The following is a list of the structures which are met with in this dissection :—

(1.) Superficial veins. { Internal saphenous. / External saphenous.

(2.) Cutaneous nerves.

(3.) Deep fascia.

(4.) Superficial muscles of the calf. { Gastrocnemius. / Plantaris. / Soleus.

(5.) Tendo-Achillis and its bursa.
(6.) Posterior tibial vessels.
(7.) Posterior tibial nerve.
(8.) Deep muscles. { Popliteus. Flexor longus hallucis. Tibialis posticus. Flexor longus digitorum.
(9.) Internal annular ligament.

Reflection of Skin.—*Incisions.*—(1.) A longitudinal incision along the middle line of the leg on its posterior aspect to the extremity of the heel. (2.) A transverse incision at the lower end of this, extending along the inner and outer margins of the foot for about two inches on either side.

The two flaps of skin thus marked out must be raised and turned outwards and inwards.

Superficial Veins.—The *internal* and *external saphenous* veins must be looked for in the substance of the fatty superficial fascia. Both of these vessels have been seen in previous steps of the dissection. The *internal saphenous vein* has been observed to arise from the inner extremity of the venous arch on the dorsum of the foot, and it has been traced upwards for a short distance in front of the inner malleolus and inner aspect of the tibia. It has also been dissected out upon the inner aspect of the thigh and knee. It can now be exposed in its course along the inner side of the leg. The *external saphenous vein* has been seen to arise from the outer end of the dorsal arch and to pass upwards behind the outer malleolus. It has also been noticed in the dissection of the popliteal space joining the popliteal vein. It should now be displayed in its whole length by tracing it upwards upon the back of the leg.

Associated with each of these veins are certain superficial nerves, and these must be displayed at the same time. The *small sciatic* is closely related to the external saphenous vein in its upper part, and the *external saphenous nerve* accompanies it in the lower half of the leg. In company with the *internal saphenous vein* we find the *internal saphenous nerve.*

Cutaneous Nerves.—These are very numerous. On the *inner side* of the leg look for—(1.) the *internal saphenous ;* (2.) the *inner branch* of the *internal cutaneous ;* and (3.) the *internal calcanear.*

The guide to the *internal saphenous* nerve is the vein of the same name. These two structures lie in close relation to each other. The *internal cutaneous* is found passing down a short distance behind the former. It usually ends about the middle of the leg. The *internal calcanear* is a branch of the posterior tibial nerve. Dissect for it in the interval between the prominence of the heel and internal malleolus. It pierces the internal annular ligament nearer the former than the latter. Its distribution to the skin of the heel and sole will be seen in a future dissection.

In the *middle line* of the leg two nerves will be found, viz., (1.) the *small sciatic,* and (2.) the *nervus communicans tibialis.* They both lie in relation to the external saphenous nerve, and they have both been previously seen in the dissection of the popliteal space. The *nervus communicans tibialis* pierces the deep fascia midway between the knee and ankle, and a short distance below this it is joined by the nervus communicans fibularis, and then acquires the name of *external saphenous.*

On the *outer aspect* of the leg certain branches of the *external popliteal nerve* are to be dissected out. The largest of these—the *nervus communicans fibularis* —must be traced downwards to the point at which it joins the nervus communicans tibialis. The nerve which results from this junction is called the *external saphenous.*

Deep Fascia.—A continuous view of the deep fascia can now be obtained by removing the remains of the superficial fat. Observe how thin and transparent it is in the upper part of the leg, and how it thickens as it is followed downwards towards the heel. At no point, however, is it very dense. As it passes over the interval between the heel and internal malleolus it forms the *internal annular ligament.* Divide the fascia along the middle line and turn it outwards and inwards. Leave the internal annular ligament intact. On raising the inner part of the fascia it will be seen to be attached to the tibia. In fact, it blends with the periosteum covering the inner surface of this bone. On turning the outer portion of fascia outwards it will be observed to be directly continuous with the fascia on the front of the leg; further, the strong intermuscular septum which passes in to join the fibula between the peronei muscles and the muscles on the posterior aspect of the leg will be demonstrated (Fig. 7 *c*, p. 107).

Superficial Muscles.—The three superficial muscles should now be examined. Remove the fat which is usually accumulated under cover of the tendo-Achillis. This should be done carefully, because subjacent to it is an important layer of fascia which stretches between the tibia and fibula, and separates the superficial from the deep group of muscles. When the fat has been removed this fascia will be seen to be very dense, and to be strengthened by numerous transverse fibres (Fig. 7 *d*, p. 107). It becomes continuous on the inner side of the ankle with the internal annular ligament—indeed, the dissector will not fail to observe that it takes a more prominent part in the formation of this ligament than the general aponeurosis of the limb. In the upper part of the leg it is very thin.

The two heads of the gastrocnemius may now be divided about an inch and a-half from their origin. On raising the upper portion of the inner head a bursa intervening between it and the condyle of the femur, and in all probability communicating with the knee-joint, will be observed. The smooth and tendinous opposed surfaces of the gastrocnemius and soleus, and the narrow tendon of the plantaris passing downwards and inwards between them, are now brought under the notice of the dissector. Reflect the plantaris and follow its tendon downwards along the inner side of the tendo-Achillis to its insertion into the os calcis. Clean the tendo-Achillis right down to the lower part of the posterior aspect of the os calcis, and then separate the soleus from its extensive attachments to the tibia and fibula. As these superficial muscles are being thrown downwards, it is necessary to divide the sural arteries, and also the nerves which are given to them by the internal popliteal. Entering the deep surface of the soleus are a number of arterial twigs from the posterior tibial and peroneal arteries which must also be severed after they have been cleaned and defined.

The tendo-Achillis should now be drawn forcibly backwards from its attachment to the os calcis. A slight touch of the knife between the tendon and the bone will display the cavity of the synovial sac which intervenes between them at this point.

Posterior Tibial Vessels and Nerve.—The termination of the popliteal artery is not exposed until the soleus is reflected. It should now be cleaned, and it will be seen to end at the lower margin of the popliteus muscle by dividing into the *anterior* and *posterior tibial* arteries. Further, the venæ comites which accompany these vessels will be observed to join at this point to form the large popliteal vein. The *anterior tibial* artery passes forwards between the two heads of the tibialis posticus muscle, to the front of the leg, where it has already been dissected.

Remove the layer of fascia which intervenes between the superficial and deep muscles, and define the *posterior tibial* vessels and nerve. Do this carefully so as not to injure the branches which proceed from them. The artery is placed between the two venæ comites, and the nerve lies first to the inner side of the vessels, but soon crosses over them and runs downwards in close contact with them externally. Observe that the three vessels and the nerve rest first upon the tibialis posticus, then upon the flexor longus digitorum, and lastly upon the lower end of the tibia and upon the ankle-joint. Now replace the superficial muscles, and you will notice how deeply they lie in the upper half of their course; below this, however, they escape from under cover of these muscles, and are covered simply by the two layers of fascia and the internal annular ligament.

The branches of the posterior tibial artery should now be studied. They are—(1.) the *peroneal*, (2.) the *muscular* to the neighbouring muscles, (3.) *nutrient*, (4.) *communicating*.

The *nutrient* artery springs from the posterior tibial close to its commencement, and giving some twigs to muscles, enters the nutrient foramen of the tibia. The *communicating* artery is given off at the lower end of the tibia, and passing transversely across the back of the tibia, joins the posterior peroneal artery. The *peroneal* artery is the large branch which proceeds from the posterior tibial about one inch below the lower margin of the popliteus muscle. In the present dissection it is seen running obliquely outwards and downwards upon the tibialis posticus to reach the fibula. It is covered in this part of its course by the soleus, and is accompanied by the nerve to the flexor longus hallucis. This artery should not be traced further at present as it sinks into the substance of the flexor longus hallucis at this point, and it is well to study the muscle first.

The branches of the *posterior tibial* nerve should now be examined. They supply the tibialis posticus, the flexor longus hallucis, and the flexor longus digitorum. One or two delicate filaments descend upon the posterior tibial artery, and may be followed to the skin, and the *plantar cutaneous* or *internal calcanear* has already been seen piercing the internal annular ligament on the inner aspect of the heel.

Deep Muscles.—The *popliteus* muscle will be seen lying upon the posterior aspect of the knee-joint and upon the posterior surface of the tibia above the oblique line. Its tendon of origin lies within the capsule of the knee-joint, and its examination should be deferred until the ligaments of this articulation are dissected. Note the strong fascia which covers the posterior surface of the muscle and trace it upwards and inwards to the inner side of the knee. Here it will be observed to be continuous with the tendon of the semimembranosus, and through it therefore the semimembranosus may be regarded as having an insertion into the oblique line of the tibia. The *flexor longus hallucis* is placed upon the posterior aspect of the fibula, and its tendon will be noticed to groove deeply the posterior border of the astragalus as it passes forwards to gain the sole of the foot. The *flexor longus digitorum* lies upon the tibia, and the *tibialis posticus* rests upon the interosseous membrane between the fleshy bellies of the two flexors.

As the two last muscles, however, are followed downwards they will be noticed to undergo a change in their relative positions. The broad tendon of the tibialis posticus inclines inwards under cover of the lower part of the flexor longus digitorum, so that it grooves the internal malleolus to the inner side of the tendon of the flexor.

The strong fascia which covers the surface of the tibialis posticus deserves more attention than is usually given to it by the dissector. To see it thoroughly and to demonstrate its attachment to the fibula on the one side and to the tibia on the other, the flexor of the toes must be pushed inwards and some of its fibres of origin divided. The flexor longus hallucis must in like manner be pushed outwards. The fascia will then be seen to serve as a surface of origin to both these muscles; and on its removal, it will also be observed to give fibres by its deep surface to the subjacent tibialis posticus.

Peroneal Artery.—This vessel may now be traced downwards as it descends amidst the fibres of the flexor longus hallucis. It gives off *muscular* twigs, a *nutrient* vessel to the fibula, and it ends about two inches above the external malleolus by dividing into the *anterior* and *posterior* arteries.

The *anterior peroneal* perforates the interosseous membrane, and it has been seen in the anterior tibio-fibular region. The *posterior peroneal* continues downwards to the posterior aspect of the external malleolus, and gives twigs to the parts upon the outer aspect of the ankle-joint. A short distance above the joint it receives the *communicating* branch from the posterior tibial artery.

Internal Annular Ligament.—The connections of this thickened band of deep fascia should be carefully studied, and also the arrangement of the structures which pass under cover of it into the sole of the foot. It bridges across the hollow between the prominence of the os calcis and the internal malleolus, and it is attached to both. Above it is chiefly connected with that layer of the deep fascia which intervenes between the superficial and deep muscles on the back of the leg, but it is also continuous with the general aponeurotic investment of the leg. Inferiorly its lower margin gives origin to the abductor hallucis, and is connected with the inner portion of the plantar fascia.

Passing under cover of this ligament the dissector will observe—(*a.*) the *posterior tibial vessels* and *nerve* ; (*b.*) to the outer side of these the tendon of the flexor longus hallucis ; (*c.*) to their inner side the tendons of the flexor longus digitorum and tibialis posticus. From within outwards these structures lie in the following order :—

(1.) Tendon of tibialis posticus.
(2.) Tendon of flexor longus digitorum.
(3.) Posterior tibial vessels.
(4.) Posterior tibial nerve.
(5.) Tendon of flexor longus hallucis.

The tendons are isolated from each other and from the vessels and nerve by septa which pass from the deep surface of the ligament to ridges on the bones.

These septa can be demonstrated by slitting up the ligament, for a short distance, in the line of the tendons. The three sheaths will then be seen to be lined by glistening synovial membrane.

Anastomoses around the Ankle-joint.—The dissector should next satisfy himself with regard to the anastomosis of arteries which takes place around the ankle-joint. On the *outer aspect* of the joint he will observe inosculations taking place between branches of the following arteries :—(*a.*) external malleolar; (*b.*) anterior peroneal; (*c.*) posterior peroneal; and (*d.*) tarsal.

On the *inner aspect* of the joint the internal malleolar anastomoses with small branches of the posterior tibial.

SOLE OF THE FOOT.

In this dissection the dissector will meet with the following structures :—

(1.) Superficial fascia and cutaneous vessels and nerves.
(2.) Deep plantar fascia.
(3.) Superficial muscles. { Abductor hallucis. Flexor brevis digitorum. Abductor minimi digiti.
(4.) External and internal plantar vessels.
(5.) External and internal plantar nerves.
(6.) Tendons of flexor longus hallucis and flexor longus digitorum.
(7.) Musculus accessorius and lumbrical muscles.
(8.) Flexor brevis hallucis, adductor hallucis, and transversus pedis.
(9.) Flexor brevis minimi digiti.
(10.) Plantar arch.

(11.) Arteria magna hallucis.
(12.) Tendons of peroneus longus and tibialis posticus.
(13.) Interossei muscles.

The limb should be placed upon the table, with the sole of the foot facing the dissector, and the ankle supported by a good-sized block.

Reflection of Skin.—Two incisions are required—(1.) A longitudinal incision along the middle line of the sole, from the heel to the root of the middle toe. (2.) A transverse cut, at the digital extremity of the mesial incision, across the sole at the roots of the toes.

Superficial Fascia and Cutaneous Nerves.—When the two flaps of skin which are traced out by the above incisions are reflected, the peculiar characters of the superficial fascia will come under the notice of the student. He will observe that it is tough and granular, and that it, in many respects, resembles the superficial fascia which covers the tuber ischii. Traversing it are tough fibrous bands, which subdivide the fatty tissue into granular lobules and connect the thick skin of the sole with the plantar fascia.

The *internal calcanear* nerve, which has already been found piercing the internal annular ligament, should be traced to its distribution. It supplies the skin of the sole in the neighbourhood of the heel.

The superficial fascia may now be removed. Divide it along the middle line of the sole, and turn it outwards and inwards, cleaning at the same time the deep fascia. As the dissector approaches the outer and inner margins of the foot respectively, some minute nerves and vessels will be observed to perforate the deep fascia in order to reach the skin. Towards the heads of the metatarsal bones, the digital vessels and nerves are unprotected by the deep fascia, and here the dissector must proceed cautiously. The nerves and vessels which go to the tibial side of the hallux and to the fibular side of the little toe are especially liable to injury as they perforate the fascia further back than the others.

Plantar Fascia.—The plantar fascia which is now brought into view will be noticed to consist of three portions—(*a.*) a central and (*b.*) two lateral parts. This subdivision is indicated by a difference in the density of the three parts and by two shallow furrows which traverse the foot in a longitudinal direction, one upon either side of the strong central portion of fascia. Each of the three portions of fascia is in relation to a subjacent muscle. The *central* portion covers the flexor brevis digitorum, the *external lateral* part clothes the abductor minimi digiti and the *internal lateral* part covers the abductor hallucis.

The central portion of the plantar fascia stands out in marked contrast to the lateral portions in point of strength and density. Observe how it expands as it passes forwards, and how it splits into five processes, which are bound together by transverse fibres, and between which, the digital vessels and nerves, and the lumbrical muscles appear. Trace these processes forwards. One goes to the root of each toe, and there divides into two slips, which embrace the flexor tendons and become fixed to the flexor sheaths and to the lateral ligaments of the metacarpo-phalangeal joint.

The *lateral* parts of the plantar fascia are weak in comparison with the central portion. They simply constitute an aponeurotic covering for the muscles, which lie subjacent. A strong band is to be noted in connection with the *outer* part. It stretches between the prominence formed by the base of the fifth metatarsal bone and the external tuberosity of the os calcis.

In connection with the plantar fascia two *intermuscular septa* have also to be studied. These pass upwards into the sole, along the line of the longitudinal furrows which mark off the central portion of the fascia from the lateral parts. They consequently lie one upon each side of the flexor brevis digitorum, and form partitions which separate it from the abductor hallucis on the one hand, and the abductor minimi digiti on the other. To demonstrate these septa, make a transverse incision through the central portion of the plantar fascia about an inch in front of the internal tuberosity of the os calcis, and also a longitudinal cut through the same piece of fascia, extending from the first incision along the middle line of the foot. Now raise the divided fascia and throw it outwards and inwards. Some difficulty will be experienced in effecting this, owing to its affording a surface of origin in its upper part to the subjacent flexor brevis digitorum. As we approach the margins of this muscle the septa are brought into view.

It is customary to look upon the muscles and tendons which we find in the dissection of the sole as being disposed in four strata, viz.:—

First layer.	Abductor hallucis. Flexor brevis digitorum. Abductor minimi digiti.
Second layer.	Tendon of flexor longus digitorum. Musculus accessorius. Lumbrical muscles. Tendon of flexor longus hallucis.
Third layer.	Flexor brevis hallucis. Adductor hallucis. Transversus pedis. Flexor brevis minimi digiti.
Fourth layer.	Interosseous muscles. Tendon of the peroneus longus. Tendon of tibialis posticus.

Superficial Muscles—Plantar Vessels and Nerves.—The lateral portions of the plantar fascia should now be raised from the subjacent muscles. The three superficial muscles of the sole are then exposed to view and their connections can be studied. The *flexor brevis digitorum* is placed in the middle, the *abductor minimi digiti* extends along the outer margin of the sole, and the *abductor hallucis* along the inner margin of the sole.

In the interval between the abductor hallucis and flexor brevis digitorum the *internal plantar nerve* and *artery* will be found. Follow the nerve towards the toes and dissect out its various digital branches. These will be observed to be four in number, and to be distributed—(*a.*) to the tibial side of the great toe; (*b.*) to the adjacent sides of the great toe and the second toe; (*c.*) to the adjacent sides of the second and third toes; and (*d.*) to the adjacent margins of the third and fourth toes. In order to trace these nerves forwards to their distribution, it is necessary to remove the integuments from the digits by making an incision along the middle of each and then throwing the skin outwards and inwards.

With the exception of the nerve which supplies the third and fourth toes, each of the other three digital trunks gives off a minute muscular twig before it bifurcates, and these must be sought for with care. The *first* digital nerve supplies an offset to the flexor brevis hallucis, the *second* digital nerve gives a twig to the first lumbrical muscle, and the *third* nerve sends a branch to the second lumbrical. Now trace the trunk of the *internal plantar nerve* backwards by carefully separating the flexor brevis digitorum and the abductor hallucis along the line of the internal intermuscular septum. It will be found to give a branch of supply to each of these muscles.

The *internal plantar artery* which accompanies the nerve of the same name is a small vessel, and may be traced as far as the inner side of the great toe.

Turn your attention in the next place to the outer margin of the sole, and carefully separate the contiguous borders of the flexor brevis digitorum and abductor minimi digiti. The *external plantar artery* and *nerve* lie for a short portion of their course in the interval between these muscles. Approaching the prominent base of the fifth metatarsal bone, the artery disappears from view by turning inwards under cover of the flexor tendons. At the same point the external plantar nerve divides into its *superficial* and *deep divisions*.

The *deep division* of the external plantar nerve cannot be dissected at present as it accompanies the external plantar artery. The *superficial division*, however, should now be traced to its distribution. It ends by dividing into two digital branches—(*a*.) to the fibular side of the little toe ; (*b*.) to the contiguous sides of the fourth toe and little toe. The *first* or *outermost* of these digital nerves, if sufficient care be taken in its dissection, will be found to supply twigs to the flexor brevis minimi digiti and to the muscles in the fourth interosseous space.

The *flexor brevis digitorum* should now be detached from the os calcis and thrown forwards. The origin of the *abductor hallucis* from the same bone and from the internal annular ligament should also be divided and the muscle turned inwards. With a little dissection the mode and place of origin of the *plantar arteries* and *nerves* will be made manifest. They are the terminal branches of the *posterior tibial artery* and *nerve*, and they arise in the hollow of the os calcis under cover of the origin of the abductor hallucis. But further, we are now in a position to trace the *external plantar artery* and *nerve* as they pass outwards upon the musculus accessorius to the point where they were first seen—viz., in the interval between the abductor minimi digiti and the flexor brevis digitorum. In this part of its course the nerve gives off two branches—(*a*) to the musculus accessorius; and (*b*) to the abductor minimi digiti.

Second Layer.—The abductor minimi digiti should be detached from its origin and turned forwards in order to make a good display of the structures composing the second stratum of the sole. Observe that as the tendon of the *flexor longus hallucis* enters the sole it inclines inwards towards the great toe, whilst the tendon of the *flexor longus digitorum* inclines outwards to reach the middle of the foot where it divides into four tendons—one for each toe. Further, note that the tendons of these two muscles cross each other in the sole—the flexor tendon of the hallux lying subjacent to the flexor tendon of the other digits, and giving to it a tendinous slip.*

The *musculus accessorius* which is inserted into the tendon of the long flexor of the toes and the four *lumbrical muscles* which arise from the flexor tendons should now be cleaned. Note the position of the long plantar ligament between the two heads of origin of the accessorius.

Flexor Sheaths.—Before tracing the flexor tendons

* Professor Turner has called attention to the fact that this slip, which passes from the tendon of the flexor longus hallucis to the tendon of the flexor longus digitorum, varies greatly in magnitude and in the manner in which it is connected with the flexor tendons of the toes. In the majority of cases it goes to the tendons of the second and third toes; in some cases, however, only to the tendon of the second toe or to the tendons of the second, third, and fourth toes. Very rarely does it divide so as to bring all the tendons of the flexor longus digitorum into connection with the tendon of the flexor longus hallucis.

forwards on the toes it is necessary to examine the sheaths which retain them upon the plantar aspect of the phalanges. Open these sheaths by making a longitudinal incision through each. This will reveal the synovial membrane which lines them and also the tendons which they enclose. Two tendons go to each of the four outer toes. The mode of insertion of these tendons and the manner in which the superficial tendon is pierced by the deep tendon should be studied. In the case of the hallux only one tendon is found inside the flexor sheath—viz., the tendon of the flexor longus hallucis.

Third Layer of Muscles.—To bring the third layer of muscles into view we require to make the following dissection:—Divide the two heads of the accessorius and draw the muscle forwards from under the external plantar vessels and nerve. Sever also the tendons of the flexor longus digitorum and the flexor longus hallucis at the point where they emerge from under cover of the internal annular ligament. Upon cutting the branch which is given by the external plantar nerve to the accessorius these structures can be thrown forwards towards the toes. On raising the lumbrical muscles the twigs which are furnished to the *third* and *fourth* by the *deep division* of the external plantar nerve must be looked for. Lastly, cut the internal plantar nerve close to its origin and turn it aside.

The *flexor brevis hallucis* lies along the outer side of the abductor hallucis. It arises by a single head of origin, but soon divides into two fleshy parts, which are inserted one upon each side of the base of the proximal phalanx of the great toe. The *adductor hallucis* has a very oblique position in the sole and hides to a great extent the interossei muscles. It lies to the outer side of the flexor brevis hallucis. The *transversus pedis* is placed transversely across the heads of the metatarsal bones. Its close association with the adductor hallucis is not generally recognised. Both are adductors of the hallux, and in some animals (certain monkeys) the two muscles are blended. Again, according to Ruge, at an early stage of the human embryo they lie side by side, in close apposition with each other, and it is only as development advances that they become separate by the transversus pedis travelling forwards so as to assume its transverse position upon the heads of the metatarsals. The *flexor brevis minimi digiti* is recognised from its lying in relation to the fifth metatarsal bone.

Plantar Arch—Deep Division of External Plantar Nerve.—The *plantar arch* is that portion of the external plantar artery which extends from the base of the fifth metatarsal bone to the posterior part of the first interosseous space. The *deep division* of the *external plantar nerve* which accompanies it must be dissected at the same time. The nerve will be observed to end in the substance of the adductor hallucis. Detach this muscle from its origin and throw it forwards. The transversus pedis, the interossei muscles with the exception of those in the fourth space and the two outer lumbrical muscles also receive twigs from the same nerve, and these must be looked for. The following Table may aid the student in his study of the distribution of the plantar nerves :—

	Digits.	Muscles.
Internal plantar nerve.	(1.) Hallux. (2.) Index. (3.) Medius. (4.) Tibial side of annularis.	(1.) Flexor brevis digitorum. (2.) Abductor hallucis. (3.) Flexor brevis hallucis. (4.) First and second lumbrical muscles.
External plantar nerve.	(1.) Fibular side of annularis. (2.) Minimus.	(1.) Accessorius. (2.) Abductor minimi digiti. (3.) Flexor brevis minimi digiti. (4.) Third and fourth lumbrical muscles. (5.) Adductor hallucis. (6.) Transversus pedis. (7.) The interossei muscles.

The *plantar arch* and the branches which proceed from it must now be studied. At its inner part it is covered by the adductor hallucis and the flexor brevis hallucis. The former has already been turned aside. The short flexor of the hallux is still in its place, and it is necessary therefore that it should be thrown forward from its origin. A little dissection will show that the arch is completed by the *dorsalis pedis artery*, which enters the sole at the back part of the interosseous space. From this arterial arcade the following branches are given off—(*a.*) *four digital* arteries from the convexity ; (*b.*) several *muscular twigs* from the concavity ;

(*c*.) three *posterior perforating* branches from the upper surface of the arch.

The *digital arteries* supply both sides of the three outer toes and the fibular side of the second toe. The *posterior perforating arteries* pass upwards to the dorsum of the foot through the back part of the three outer intermetatarsal spaces.

Arteria Magna Hallucis.—This artery arises from the *dorsalis pedis* as it lies between the first and second metatarsal bones. On dissecting its branches it will be seen to supply the adjacent sides of the hallux and second toe, and also to send a branch to the tibial side of the hallux.

Fourth Layer of Muscles.—A satisfactory display of the *interossei* muscles cannot be obtained unless the transverse metatarsal ligament be divided between the heads of the metatarsal bones. The toes can now be separated more freely from each other, and the interossei muscles traced to their insertions. It is well also to reflect at this stage the flexor brevis minimi digiti.

The *plantar interossei* are three in number, and are so placed that they adduct the three outer toes towards a line drawn through the second toe. They lie upon the plantar aspect of the three outer metatarsal bones, and are inserted one upon the tibial side of each of the toes which correspond to these metatarsals. The *dorsal interossei* are four in number. They occupy the four intermetatarsal spaces, and consequently they must be dissected both upon the plantar and dorsal aspects of the foot. They are arranged so as to abduct the four outer toes from a line drawn through the second toe. They are inserted, therefore, as follows:—*the first* upon the tibial side of the second toe; *the second* upon the fibular side of the same toe; *the third* upon the fibular side of the third toe; and *the fourth* upon the fibular side of the fourth toe.

Man stands alone in regard to this arrangement of the interossei muscles. In other mammals the interossei of the pes are arranged in a manner similar to those of the manus—viz., with reference to a line drawn through the middle digit.

Before leaving the sole the dissector must determine the precise insertions of the tendons of the *tibialis posticus* and *the peroneus longus*. The tendon of the *tibialis posticus* is not merely inserted into the tubercle of the scaphoid. Fibrous slips are seen to spread out from it, and these may be traced to every bone of the tarsus with the exception of the astragalus, and also to the bases of the second, third, and fourth metatarsal bones. The tendon of the *peroneus longus* as it traverses the sole will be seen to be enclosed in a fibrous sheath. Note that this sheath is mainly formed by fibres derived from the long plantar ligament. Open the sheath and its smooth, glistening, internal surface will be displayed. This appearance is due to the synovial membrane which lines it.

Anastomoses around the Knee-joint.—The dissector should now study in a connected manner the anastomoses of blood-vessels around the knee and also the nerves which supply the joint, and he should avail himself of this opportunity before he proceeds to examine the articulations of the lower limb.

Upon the *outer* aspect of the joint he will find from above downwards the following arteries :—

(1.) Descending branch of the external circumflex.
(2.) Superior external articular.
(3.) Inferior external articular.

Upon the *inner aspect* of the joint there are also three arteries, viz. :—

(1.) Articular branch of the anastomotica magna.
(2.) Superior internal articular.
(3.) Inferior internal articular.

Ascending upon *the anterior aspect* of the joint will be found the *recurrent tibial* artery. These seven arteries ramify upon the anterior and lateral aspects of the knee-joint and effect very complete anastomoses.

The dissector should very particularly examine the relations of the articular branches of the popliteal artery. Each *superior articular* artery as it winds round the femur will be seen to pierce the intermuscular septum of its own side. The superior internal articular will also be observed to pass under cover of the round tendon of the adductor magnus. Each *inferior articular* artery passes under cover of the lateral ligament of its own side.

Articular Nerves of the Knee-joint.—An articular nerve will be found accompanying each of the seven anastomosing arteries. In addition to these, two articular nerves are associated with the *azygos articular* artery, and one is given to the pouch of synovial membrane which projects upwards under cover of the quadriceps extensor tendons. There are thus *ten* nerves of supply to the joint, and they are derived as follows:—(1.) three from the *internal popliteal* to accompany the two internal articular arteries and the *azygos artery;* (2.) three from the *external popliteal* to accompany the two external articular arteries and the recurrent tibial artery; (3.) one from the *deep* division of the *obturator* which pierces the posterior ligament of the knee-joint with the azygos artery; (4.) three from the *anterior crural;* two of these come from the nerves of supply to the vastus externus and vastus internus respectively, and they accompany the descending branch of the external circumflex and the articular branch of the anastomotica magna; the third comes from the nerve to the subcrureus, and supplies the upper part of the synovial pouch (*vide* p. 96).

The dissection of the knee-joint, the ankle-joint, and of the various articulations of the foot may now be proceeded with. In all probability the ligaments have become hard and dry. If this be the case, soak the joints in hot water for an hour or two, and then rub them with a hard brush. The dissection will in this way be greatly facilitated.

THORAX.

THE dissection of the thorax is commenced on the *tenth* day* after the subject has been placed in the Rooms. By this time the upper limbs have been detached from the trunk.

THORACIC WALL.

There is a very prevalent idea amongst students that little or nothing is to be gained by a dissection of the walls of the thorax. Their great aim seems to be to open into the cavity with the least possible delay. This is a great mistake. *Two days* at least should be devoted to this dissection.

The student will find that, in addition to the osseous and cartilaginous framework, the walls of the chest are built up partly by muscles, and partly by membranes, and that in connection with these are numerous nerves and blood-vessels.

Muscles. { External intercostals. Internal intercostals. Triangularis sterni.

* Saturdays and Sundays are not counted as anatomical days.

Membranes.	Anterior intercostal membrane. Posterior intercostal membrane. Pleural membrane (parietal part).
Nerves and Arteries.	Intercostal nerves. Aortic intercostal arteries. Superior intercostal artery. Internal mammary artery.

Portions of certain of the muscles of the upper limb and of the abdominal wall will be noticed attached to the thoracic wall. From before, backwards, the dissector will meet with the *pectoralis major*, the *pectoralis minor*, and the *serratus magnus*, whilst towards the lower margin of the chest he will recognise the *rectus abdominis* in front, and the *obliquus externus* and *latissimus dorsi* upon its lateral aspect. The rounded tendon of the *subclavius* may also be observed taking origin from the first costal arch, and posteriorly to this the *scalenus posticus* extends downwards to its insertion into the second rib. With the single exception of the scalenus posticus, these muscles should be removed so as to lay bare the costal arches and the intercostal muscles. In detaching the serratus magnus be careful not to injure the *lateral cutaneous* nerves which make their appearance in the intervals between its digitations. The *anterior cutaneous* nerves and the *perforating* branches of the internal mammary artery must also be preserved; they pierce the origin of the pectoralis major in the intervals between the costal cartilages, and close to the margin of the sternum.

Intercostal Muscles.—These are the muscles which occupy the eleven intercostal spaces. In each space there are two strata of muscular fibres—a superficial and a deep. The superficial layer of muscular fibres is called the *external intercostal* muscle, and the deep layer the *internal intercostal* muscle.

The *external intercostal* muscles are already exposed, and very little cleaning is necessary to bring out their connections. Observe that entering into their constitution there is a large admixture of tendinous fibres, and that these, as well as the muscular fibres, are directed from above, obliquely downwards and forwards. They do not extend further forwards in the various spaces than a point corresponding to the union of the bony with the cartilaginous parts of the costal arches. Here the muscular fibres stop short, but the tendinous fibres are prolonged onwards to the sternum in the form of a membrane which may be called the *anterior intercostal* membrane. The external intercostal muscles of the two lower spaces are exceptions to this rule. They extend forwards to the extremities of the spaces. Posteriorly the muscles pass backwards as far as the tubercles of the ribs, but this is a point which can only be satisfactorily demonstrated after the thorax has been opened into.

To bring the *internal intercostal* muscles into view it is necessary to reflect the external intercostal muscles, and also the anterior intercostal membranes. Divide them along the upper borders of the ribs which bound the spaces inferiorly, and throw them upwards. This dissection should be performed in each intercostal space, and, in effecting it, care must be taken of the intercostal arteries which lie between the two muscular strata.

The *internal intercostal* muscles thus laid bare will be seen to be similar in their constitution to the external muscles. The fibres, however, run in the opposite direction—viz., from above, obliquely downwards and backwards. Moreover, the muscles are prolonged forwards to the sternum. Posteriorly they reach backwards to the angles of the ribs, from which to the spine, this stratum is continued in the form of a thin membrane—the *posterior intercostal membrane*—which will be seen after the thorax has been opened. If the internal oblique muscle of the abdomen has not been removed, the dissector should note how the anterior fibres of the two lowest *internal intercostal* muscles become continuous with the fibres of that muscle.

Intercostal Nerves.—The intercostal nerves are altogether out of sight in the present stage of the dissection. They are hidden by the lower borders of the ribs which bound the intercostal spaces superiorly. By gently pulling upon their lateral cutaneous branches they can be drawn downwards, and they are then seen to lie between the two muscular strata as far forward as a point midway between the spine and sternum. Here they disappear from view by sinking into the substance of the internal intercostal muscles, amidst the fibres of which they may be traced as far as the anterior extremities of the bony ribs. They now reach the deep surface of these muscles and are carried inwards, first upon the pleura, and then upon the triangularis sterni muscle. Lastly, they cross the internal mammary artery and come forwards at the side of the sternum as the *anterior cutaneous* nerves of the pectoral region. Before it reaches the surface each nerve pierces (*a.*) the internal intercostal muscle, (*b.*) the anterior intercostal membrane, (*c.*) the origin of the pectoralis major, and (*d.*) the deep fascia.

The intercostal nerves give twigs to the intercostal muscles, and also to the triangularis sterni. The lower six nerves on leaving the intercostal spaces pass forwards between the abdominal muscles.

It is not necessary to make a dissection of these nerves in more than two or three of the spaces.

Intercostal Vessels. — The intercostal arteries should be dissected in those spaces in which the nerves have not been traced, and in which, therefore, the internal intercostal muscles are still entire. It is only in a well-injected subject that a satisfactory view of these vessels can be obtained. In each intercostal space *one* artery is found passing from *behind forwards*, and *two*, the *anterior intercostal* arteries, running from *before backwards.*

In the upper two spaces the vessels which run from behind forwards are derived from the *superior intercostal* branch of the subclavian artery; in the nine lower spaces they spring directly from the aorta, and are called the *aortic intercostals.*

The *anterior intercostal* arteries of the upper seven spaces proceed directly from the internal mammary, whilst in the case of the four lower spaces they come from the outer of its two terminal branches—viz., the musculo-phrenic.

The intercostal vessels are distributed between the two muscular strata. From the angles of the ribs onwards to a point midway between the spine and sternum, the *aortic intercostals* lie under shelter of the lower margins of the ribs which bound the spaces superiorly, and at a higher level than the corresponding nerves. Here each divides into two branches, and these pass forwards in relation to the upper and lower margins of the intercostal space. They give off small branches which accompany the lateral cutaneous nerves. The *superior intercostal* arteries are disposed in a similar manner. The *anterior intercostal* arteries at their origin lie under cover of the internal intercostal muscles, but they soon pierce these and run outwards in relation to the upper and lower margins of each space. They end by anastomosing with the aortic and superior intercostal arteries.

The dissector should next proceed to remove the intercostal muscles. This dissection must be carried out with more than usual care, because immediately subjacent to the internal intercostal muscles, over the greater extent of the chest, is the delicate pleural membrane lining the inner surface of the costal arches. *Upon no account detach this membrane from the deep surface of the ribs.*

On the front of the chest the *internal mammary* artery and the *triangularis sterni* muscle will be seen to intervene between the pleura and the costal cartilages. Towards the lower margin of the thorax the pleural sac is not prolonged downwards to the lowest limit of the recess between the diaphragm and the costal arches. Indeed, in the axillary line, it will be found to fall short of this by about two or two and a-half inches. Consequently, when the internal intercostal muscles are removed from this portion of the chest wall, the dissector will come down directly upon the diaphragm, and as the fibres of the diaphragm correspond somewhat in their direction with those of the internal intercostal muscles, it is no uncommon occurrence for the student to remove them, and thus expose the peritoneum, under the impression that he has simply laid bare the pleura. When the dissection has been properly executed, a thin fascia will be observed to pass from the surface of the diaphragm on to the surface of the costal pleura so as to hold it in position.

Triangularis Sterni and Internal Mammary Artery.—The *triangularis sterni* muscle should be studied at this stage of the dissection. A tolerably good idea of its connections can be obtained *without dividing* the costal cartilages, a step which is frequently recommended. Lying on its superficial aspect are the series of intercostal nerves and the internal mammary artery.

The *internal mammary* artery should be followed downwards in the intervals between the cartilages. It lies fully half-an-inch to the outside of the margin of the sternum, and is accompanied by two veins. In the interval between the sixth and seventh costal cartilages it ends by dividing into (*a.*) the *musculo-phrenic*, which runs outwards along the origin of the diaphragm, and (*b.*) the *superior epigastric*, which passes downwards within the sheath of the rectus abdominis muscle. Note how the internal mammary lies between the costal cartilages and the pleura in the first part of its course, and between the cartilages and triangularis sterni in the lower and greater part of its course. Note further that it is crossed by the intercostal nerves before they turn forwards to gain the surface.

The *perforating arteries* and the *anterior intercostal arteries* of the upper seven spaces are now seen to spring from the internal mammary.

THORACIC CAVITY.

In the thoracic cavity the following structures come under the notice of the student :—

(1.) The two pleural sacs.
(2.) The phrenic nerves.
(3.) The lungs.
(4.) The roots of the lungs.
(5.) The remains of the thymus body.
(6.) The superficial cardiac plexus.
(7.) The pericardium.
(8.) The superior vena cava and innominate veins.
(9.) The heart.
(10.) The pulmonary artery.
(11.) The pulmonary veins.
(12.) The arch of the aorta and its branches.
(13.) The deep cardiac plexus.

(14.) The trachea and bronchi.
(15.) The pneumogastric nerves.
(16.) The œsophagus.
(17.) The thoracic aorta and its branches.
(18.) Thoracic duct.
(19.) The gangliated cord of the sympathetic and the splanchnic nerves.
(20.) Azygos veins. { Vena azygos major. Vena azygos minor superior. Vena azygos minor inferior.

Pleura.—The dissection which has already been made shows the pleura lining the deep surface of the costal arches. This portion of the membrane is termed the *parietal pleura* or *pleura costalis.* The manner in which it enters into the formation of the anterior mediastinal space should now be examined. This entails a somewhat complicated dissection.

The sternum must be divided with the saw into four portions by three separate cuts, viz.:—(1.) A transverse section through the manubrium sterni, on a line with the *lower* margins of the first pair of costal cartilages. (2.) A transverse cut through the lower part of the body of the sternum, in the interval between the *fifth* and *sixth* costal cartilages. (3.) An oblique section, beginning below at the inferior transverse cut, close to the left margin of the sternum, and carried upwards to the middle of the superior transverse cut. By the last section the central portion of the sternum is divided into two lateral pieces, to each of which four costal arches are attached.*

* This dissection was devised by Professor Turner, and has been practised in the University dissecting-rooms for the last twenty years.

Whilst making the above dissection the greatest care must be taken not to separate the parietal pleura, at any point, from the deep surface of the thoracic parieties.

Let the student in the next place gently separate the two lateral portions of the central piece of the

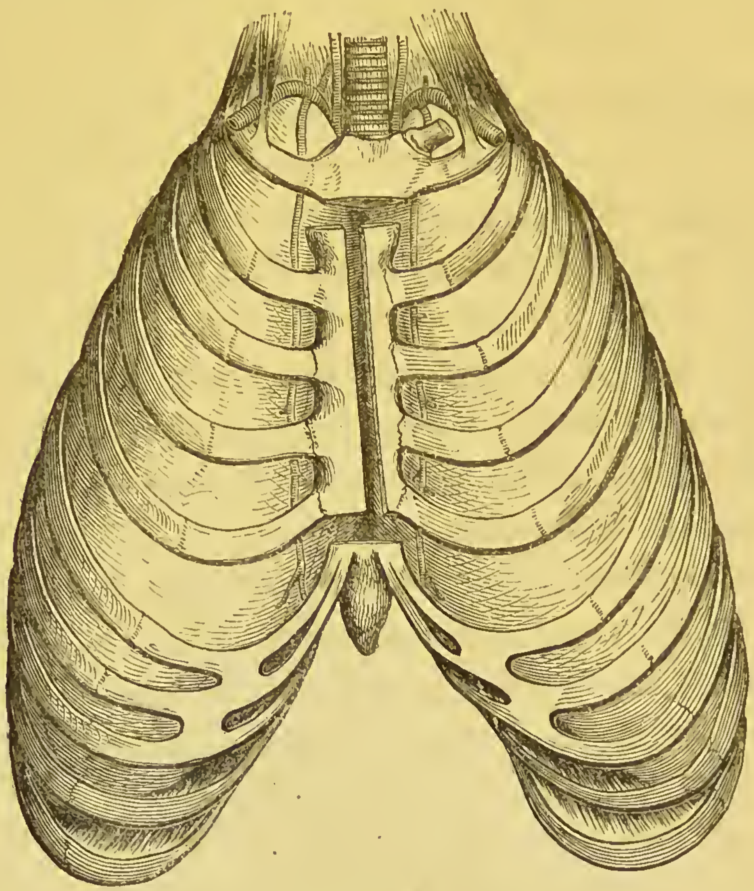


FIG. 8.

Dissection to display the anterior mediastinal space.

sternum from each other, and look between them. He will see a narrow strip of the anterior surface of the pericardium obscured by some loose areolar tissue. But, further, he will observe the parietal pleura upon each side leaving the back of the sternum so as to reach the pericardium. Here, then, is the anterior mediastinal space exposed to view, and its boundaries brought clearly before the student—*in front*, the posterior surface of the sternum clothed in its lower part by the left triangularis sterni muscle, and above by the origins of the sterno-hyoid and sterno-thyroid muscles; *behind*, the pericardium covered by some loose areolar tissue in which ramify a few lymphatic vessels and some minute arterial twigs from the internal mammary artery; and *upon each side*, the pleura as it passes from the back of the sternum to the front of the pericardium.

The remains of the *thymus gland* constitute the only content of this space. It is situated in its upper part.*

The student will now understand the object in making the section through the central portion of the sternum extend from the left margin of the bone obliquely upwards. He will notice that, whilst the right pleura extends upon the back of the sternum to the middle line of the body, the left pleura falls somewhat short of this. The anterior mediastinal space, therefore, is placed to the left of the mesial plane.

The parietal pleura should now be separated from

* The left internal mammary artery, the left triangularis sterni muscle, and the origins of the sterno-hyoid and sterno-thyroid muscles are frequently described as contents of this space. So far as the internal mammary artery is concerned the statement is altogether erroneous. In no part of its course does it lie within the space. It is immaterial whether the student looks upon the origins of the sterno-hyoid and thyroid as being contents, or as entering into the formation of the anterior boundary. The triangularis sterni should certainly be regarded as a boundary, because the pleura is reflected from the deep surface of the muscle on to the pericardium. Indeed, we might as well look upon the serratus magnus muscle as being a content of the axillary space.

the ribs as far forward as the cartilages. This can best be done by gently insinuating the forefinger between each of the ribs and the pleura, and then running it backwards and forwards. Upon no account detach the pleura from the cartilages. Next divide with the knife the *second*, *third*, *fourth*, *fifth*, and *sixth* costal arches at the junction of the osseous with the cartilaginous portions, and remove these ribs by snipping through them with the bone pliers as far back as possible. The sternum and cartilages, to which the pleura is still adherent, must be left in position until the arrangement of the membrane has been thoroughly investigated.

The greater part of the costal pleura now lies flaccid upon the surface of the lung. Make a vertical incision through it, midway between the spine and sternum, from the level of the second costal arch down as far as the seventh rib. From each extremity of this vertical cut carry an incision forwards for two or three inches.

A considerable piece of the parietal pleura can now be thrown forwards like a door, and the hand can be introduced into the pleural sac so as to explore its extent and connections. First carry it inwards behind the cartilages. Its passage across the middle line of the body is effectually barred by the reflection of the pleura from the back of the sternum to the front of the pericardium. By separating the pleura from the pericardium with the handle of the knife or with the fingers, the pleura can be traced backwards upon the lateral aspect of the pericardium to the root of the lung. Upon this it passes outwards so as to envelope the lung. The smooth, glistening surface of this organ is due to the pleural investment which it thus acquires. When the pleura is stripped from the side of the pericardium the phrenic nerve which lies between them will be brought into view. From the back of the lung the pleura is prolonged over the root of the lung to the posterior aspect of the pericardium, and it no sooner reaches this than it is directed backwards to the sides of the vertebral bodies, from which it passes outwards to clothe the inner aspect of the ribs.

The pleural sac of the one side is therefore quite distinct from the pleural sac of the other side, and the interval which is left between them is called the *mediastinum* or *mediastinal space*. This space is arbitrarily divided into an *anterior*, *middle*, and *posterior* part.

The *anterior mediastinum* has already been studied. The *posterior mediastinum* is bounded *in front* by the posterior aspect of the pericardium, *behind* by the bodies of the vertebræ, and *upon each side* by the pleura as it is directed backwards from the pericardium to the spine. It contains a number of important structures which it is needless to enumerate before the dissection of the space is undertaken. The *middle mediastinum* is that portion of the interpleural space which is occupied by the heart, pericardium, and phrenic nerves.

But a *superior mediastinum* is also somtimes described. The term is applied to that portion of the interpleural space which lies above the pericardium. *In front* it is bounded by the manubrium sterni, to the upper and posterior aspect of which the sterno-hyoid and sterno-thyroid muscles are attached; *behind*, by the vertebræ; and *laterally*, by the pleura.*

Introduce the hand a second time into the pleural sac, and pass it upwards. The pleura will be observed to extend upwards into the root of the neck, and to form in this locality a dome-shaped roof for each side of the chest. The height to which the *cervical pleura* rises above the level of the first rib varies from one inch to one inch and a-half. The subclavian artery arches over this *cul-de-sac*, and the scalenus anticus muscle is in relation to its outer surface.

In the next place, enlarge the opening in the pleural sac, and draw the basal portion of the lung outwards and upwards. The pleura will be seen to clothe the upper surface of the diaphragm (*diaphragmatic pleura*), and a triangular fold of pleural membrane extending from the lower border of the root of the lung to the diaphragm will be brought into view. This fold is called the *ligamentum latum pulmonis*.

The term *mediastinal pleura* is given to that portion

* If this method of description be adopted, the superior mediastinum must be considered to contain the following structures:—

(1.) The remains of the thymus body.
(2.) The two innominate veins, the commencement of the superior vena cava, and the termination of the vena azygos major.
(3.) The transverse portion of the aortic arch and the three great arteries which spring from it.
(4.) The pneumogastric, phrenic, cardiac, and left recurrent laryngeal nerves for a certain part of their course.
(5.) Portions of the trachea, œsophagus, and thoracic duct.

of the pleural sac which forms the lateral boundary of the mediastinal space—*i.e.*, to that portion of the membrane which extends from the sternum to the vertebræ; and, where the root of the lung intervenes, it applies to the pleura which passes from the sternum to the anterior aspect of the root, and from the posterior aspect of the root to the vertebræ.

The central piece of the sternum, with the attached costal cartilages, may now be removed, together with the triangularis sterni muscle, the costal pleura, and that portion of the pleura which is in relation to the pericardium.

Branches of Internal Mammary.—The *internal mammary* artery will be observed to give off a long slender branch, which accompanies the phrenic nerve to the diaphragm. It is called the *arteria comes nervi phrenici*. *Mediastinal* and *thymic* twigs also come from the internal mammary, but these are very minute, and can only be satisfactorily studied when the injection of the body has been more than usually successful. The following, then, are the branches of the internal mammary artery:—

(1.) Perforating.
(2.) Anterior intercostal.
(3.) Comes nervi phrenici.
(4.) Mediastinal and thymic.
(5.) Musculo-phrenic.
(6.) Superior epigastric.

Lungs.—The lungs should next occupy the attention of the dissector. He must carefully study their position, form, connections, and the points in which they differ from each other. *With the consent* of the dissector of the head and neck, he may introduce the nozzle of the bellows into the cervical portion of the trachea and inflate them with air. He will, in this way, be able to form a truer conception of these organs than he would by simply examining them in their present collapsed condition.

Root of the Lung.—This is the term which is applied to a number of structures which enter the lung at the hilum or slit upon its inner concave surface. These structures are held together by an investment of pleura, and thus constitute a pedicle which retains the lung in its place.

The pleura should be carefully stripped from around the root of the lung; but, before undertaking the dissection of the parts which compose the root, the relation which it bears to neighbouring parts should be determined.

In front, there are—(1.) A delicate plexus of nerves, the anterior pulmonary plexus; and (2.) The phrenic nerve with the arteria comes nervi phrenici. *Behind*, the pneumogastric nerve breaks up into the posterior pulmonary plexus; whilst, *inferiorly*, there is the ligamentum latum pulmonis. These are the relations which are common to the root of the lung upon each side of the body, but there are others which belong specially to the side that we are examining.

On the *right side*—(1.) The vena azygos major, as it passes forwards to join the superior vena cava, is in relation to the upper border of the pulmonary root; (2.) The superior vena cava, in the lower part of its course, lies in front of the pulmonary root.

On the *left side*, the arch of the aorta arches over the root of the lung, and the descending thoracic aorta passes down behind it.

Now proceed to dissect out the constituent parts of the root of the lung. The most important structures which enter into its formation are—(1.) the *two pulmonary veins*; (2.) *the pulmonary artery*; (3.) *the bronchus*. But, in addition to these, there are also one or two small *bronchial arteries* and *veins*, the *pulmonary nerves*, and the *pulmonary lymphatic vessels*. These are bound together by some loose areolar tissue, and the whole is invested by pleura.

The *pulmonary nerves* are derived from the anterior and posterior pulmonary plexuses. The *anterior pulmonary plexus* is composed of two or three exceedingly delicate filaments which come from the pneumogastric nerve. These join with the sympathetic twigs on the wall of the pulmonary artery. The plexus of the left side is larger than that of the right side, because it receives a few filaments from the superficial cardiac plexus. The deep cardiac plexus gives twigs to the anterior pulmonary plexus on both sides of the body. It is only under the most favourable circumstances that a good dissection of these nerves can be made. The *posterior pulmonary plexus* is easily dissected. It represents the entire trunk of the pneumogastric nerve broken up so as to assume a plexiform arrangement upon the posterior aspect of the pulmonary root.

Several twigs from the sympathetic enter this plexus. From both anterior and posterior pulmonary plexuses nerves are prolonged into the interior of the lung.

The *bronchial arteries* are the proper nutrient vessels of the lung. They convey the blood which supplies the lung-substance ; and they are usually placed upon the posterior aspect of the bronchus.

The *pulmonary vessels* and the *bronchus* should now be separated from each other with the handle of the knife, and their relative positions in the root of the lung studied. The *veins* are placed *most anteriorly* and the *bronchus most posteriorly*, whilst the *artery* is *intermediate* in position. When examined in respect to their relations from above downwards, the two sides of the body differ from each other. On both sides *the veins* occupy the *lowest* level. On the *right side* the bronchus is highest and the artery intermediate, whereas on the *left side* the artery is highest and the bronchus intermediate in position. The left bronchus descends lower in the chest than the right bronchus, and thus comes to lie intermediate between the pulmonary veins and the pulmonary artery.

These relations may be shortly expressed thus :—

From before backwards.

Both sides
Veins.
Artery.
Bronchus.

From above downwards.

Left side	*Right side*
Artery.	Bronchus.
Bronchus.	Artery.
Veins.	Veins.

Phrenic Nerve.—The *phrenic nerve* has already been observed lying against the side of the pericardium, a short distance in front of the root of the lung. In this position it is retained by the mediastinal pleura. It should now be followed upwards towards the neck, and downwards to the diaphragm. As it enters the thorax it passes behind the subclavian vein and crosses the internal mammary artery from without inwards. Reaching the diaphragm, it breaks up into branches which pierce this structure, and are distributed to it upon its under surface.

The nerves of the two sides differ somewhat from each other in certain particulars—(1.) The left phrenic is considerably longer than the same nerve on the right side of the body; (2.) the left phrenic crosses the arch of the aorta; (3.) the right phrenic lies in relation to the right side of the right innominate vein and the superior vena cava.

Pericardium — Superficial Cardiac Plexus.—The *superficial cardiac plexus* of nerves should next engage the attention of the dissector. The best plan to adopt in making a dissection of these delicate nervous filaments is to begin by securing the two cardiac nerves which enter the plexus from above, and trace them downwards. These nerves are—(1.) the *cardiac branch* from the *superior cervical ganglion* of the *left* side; (2.) the *inferior cardiac branch* of the *left pneumogastric* nerve.

Look for these nerves upon the arch of the aorta. They will be found crossing it to the left of the phrenic nerve between it and the pneumogastric nerve. The cardiac branch from the left pneumogastric is the smaller of the two, and it may be recognised from its lying nearer the phrenic than the other. The superficial cardiac plexus can now be dissected. Its position upon the left pulmonary artery in the concavity of the aortic arch should be noted, as also the numerous twigs which it receives from the deep cardiac plexus.

The pericardium should now be cleaned. In removing the loose areolar tissue from its anterior surface you will in all probability notice two ligamentous bands which connect it to the posterior aspect of the sternum. Of these, one—the *inferior sterno-pericardiac ligament*—binds it to the ensiform cartilage, whilst the other—the *superior pericardiac ligament*—connects it with the manubrium sterni. The upper surface of the diaphragm should be carefully cleaned at the same time, in order that its relation to the pericardium may be studied.

The pericardium is a conical sac, the base of which rests upon the diaphragm. When denuded of the loose tissue which surrounds it, the strong dense character of the fibrous membrane which forms the *outer layer* of the sac will be seen. Note how the pericardium narrows as it is traced upwards, how its outer fibrous layer is pierced by the various vessels which pass to and from the heart, and how this layer is gradually lost upon the coats of these vessels. Next examine it in its relation to the diaphragm. It will be seen to lie upon the central tendon, but also to extend outwards for a short distance on the muscular fibres upon the left side of the tendon. Except at one point, no difficulty will be experienced in separating the fibrous pericardium from the diaphragm. The two are simply bound together by a little intervening areolar tissue. Towards the middle line the fibrous pericardium, however, will be found, over a small area, to be inseparably blended with the central tendon of the diaphragm.

The pericardium may now be opened by means of a crucial incision, viz.—(1.) a longitudinal incision along the middle line of the body from the point where it blends with the sheath of the aorta downwards to the diaphragm; (2.) a transverse cut extending from the middle of the root of one lung to a similar point on the opposite side.

The *serous internal layer* of the pericardium is now brought under the notice of the student. This layer lines the entire inner surface of the fibrous pericardium and is reflected from this on to the surface of the heart. There is a decided difference, then, in the manner in which the fibrous and serous layers of the pericardium are related to the heart and its great vessels. The great vessels pierce the fibrous pericardium. The serous pericardium reaches the heart by being continued over the surface of these vessels. Each vessel, before it pierces the fibrous layer, is thus enclosed within a short tubular sheath of serous pericardium. In the case of the aorta and pulmonary artery, however, you should note that both are surrounded by the same sheath.

Lastly, separate the left pulmonary artery from the upper of the two left pulmonary veins and look into the interval between them. You will observe a prominent fold of serous pericardium. This is "*the vestigial fold of Marshall*," the remnant of the left superior vena cava of the embryo.

The branches of the *superficial cardiac plexus* may now be traced downwards. They descend in the groove between the pulmonary artery and the aorta, and being joined by some twigs from the deep cardiac plexus, they are distributed upon the heart in connection with the left coronary artery, and under the name of the *anterior coronary plexus*.

Innominate Veins — Superior Vena Cava. — The *innominate vein* of each side is formed behind the sternal extremity of the clavicle by the union of the subclavian and internal jugular veins. A little way below the first costal cartilage of the right side they unite to form the superior vena cava. The *right innominate vein* is short and has a nearly vertical course. Its outer surface is clothed by pleura, and is in relation to the phrenic nerve. Internally it is in contact with the innominate artery. The *left innominate vein* is much longer, and has an oblique course. In order to bring it into view it is necessary to remove the fatty areolar tissue which, in the adult, is the only representative of the thymus gland. The vein will then be seen to cross the three great arteries which spring from the transverse part of the aortic arch.

If care has been taken in cleaning these veins several tributaries will be observed joining each of them, viz.—(1.) the *inferior thyroid* vein; (2.) the *internal mammary* vein; (3.) the *superior intercostal* vein.

The *superior vena cava* should also be examined at this stage. Its mode and place of origin have already been noted. It opens inferiorly into the right auricle of the heart. Note particularly its relation to the pericardium. The fibrous pericardium clothes it for about one inch and a-half above its termination, whilst the serous pericardium gives it a tubular sheath of nearly the same extent. At the point where the fibrous pericardium blends with the coats of the vein it is joined by the vena azygos major which comes forward above the right bronchus for this purpose. Now study the relations of the superior vena cava; to *the right* is the pleura and phrenic nerve; to *the left* is the ascending part of the arch of the aorta; *posteriorly* it is in relation to the root of the lung.

THE HEART AND ITS VESSELS.

The position, relations, and external configuration of the heart should now be studied, and before opening its chambers it is well to dissect the vessels and nerves which are distributed upon its surface.

Coronary Arteries.—These are two in number. They will be found by dissecting deeply upon each side of the root of the aortic arch, from each side of which one will be seen to take origin. The *left coronary* artery springs from the left anterior sinus of Valsalva and proceeds outwards behind the pulmonary artery. It now winds round the left side of the heart, and ends on its posterior aspect by anastomosing with the right coronary artery. Throughout its entire course it lies in the auriculo-ventricular groove. It gives off numerous twigs to the left auricle and left ventricle, and a large branch will be observed to pass downwards in the anterior interventricular groove.

The *right coronary artery* arises from the right anterior sinus of Valsalva, and winds round the right margin of the heart in the auriculo-ventricular groove to reach its posterior aspect, where it ends by inosculating with the artery of the left side. An arterial circle is thus formed, which embraces the base of the heart. The right coronary artery gives off two large branches. Of these one passes downwards upon the right sharp margin of the heart, whilst the other descends towards the apex in the posterior interventricular groove. It also supplies numerous smaller twigs to the right side of the heart.

Accompanying each of these arteries are minute nerves from the cardiac plexus.

Cardiac Veins.—Take hold of the heart by the apex and pull it upwards, so as to bring into view its posterior surface. In the groove between the left ventricle and left auricle, you will notice the *coronary sinus*—a short wide venous channel (Fig. 11 *a*, p. 174). Open it with the scissors along its whole length. By one extremity it opens into the right auricle, whilst by its other end it becomes continuous with the *great cardiac* vein (Fig. 11 *b*, p. 174), and the point of junction is marked by a valve of two segments. Several *posterior cardiac* veins from the posterior aspect of the ventricles also open into this sinus, and each orifice is guarded by a distinct valve. Of these, one is much larger than the others, and ascends in the posterior interventricular groove. Lastly, the *oblique vein* of Marshall from the back of the left auricle opens into the sinus close to the point where it joins the right auricle. The orifice of this vein is devoid of a valve.

The *great cardiac vein* (Fig. 10, p. 169) begins upon the anterior aspect of the heart at the apex. It ascends in the anterior interventricular groove to the auriculo-ventricular groove, in which it turns round the left margin of the heart to join the coronary sinus. On its way it is joined by numerous veins from the left ventricle and auricle.

The *anterior cardiac* veins will be seen on the front of the right ventricle. They open directly into the right auricle (Fig. 9, p. 166, and Fig. 10, p. 169).

But, in addition to these veins which appear upon the surface of the heart, there are minute vessels in the wall of the right auricle—the *venæ Thebesii*—the orifices of which will be recognised, when the right auricle is opened, as the foramina Thebesii.

The cardiac veins, therefore, are very complicated in their arrangement, and do not correspond with the arteries. The following table may help the student in learning them :—

Upon the surface of the heart.	Great cardiac vein. Posterior cardiac veins. Oblique vein.	*Opening into* coronary sinus.
	Anterior cardiac veins.	*Opening into* right auricle.
In the substance of the heart.	Venæ Thebesii.	*Opening into* right auricle.

It is only in a heart which has been specially injected that all these veins can be seen. The general arrangement, however, can usually be studied in the course of an ordinary dissection.

The chambers of the heart should now be opened in the order in which the blood flows through them.

Right Auricle.—Draw the heart well over to the left side of the body. Fig. 9 shows the direction in which

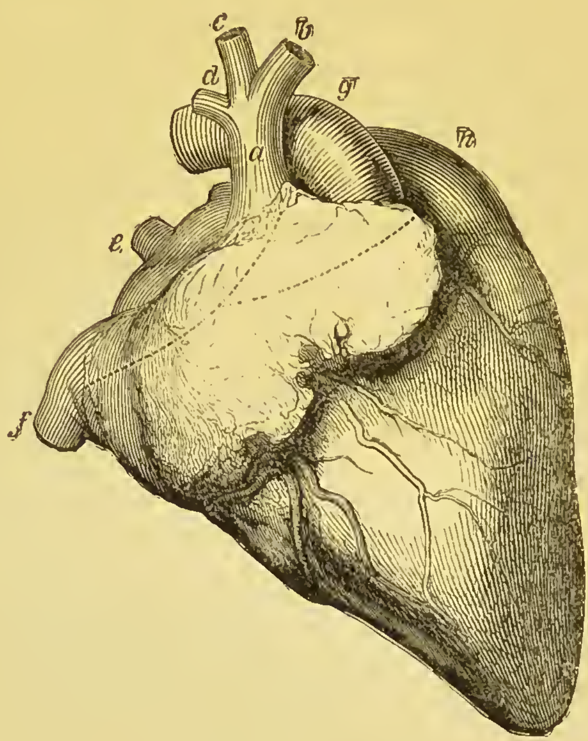


FIG. 9.

Diagram to show the manner in which the right auricle should be opened. The dotted lines give the directions in which the two incisions should be made. *a*, Superior vena cava; *b*, Left innominate vein; *c*, Right innominate vein; *d*, Vena azygos major; *e*, One of the pulmonary veins; *f*, Inferior vena cava; *g*, Aortic arch; *h*, Pulmonary artery.

the incisions through its walls must be made. Two cuts are required—(1.) A vertical incision from the point at which the superior vena cava enters the auricle to the point of entrance of the inferior vena cava. In making this incision care must be taken not to injure the Eustachian valve—a fold of endocardium placed in front of the mouth of the inferior vena cava. (2.) An oblique incision carried from about the middle of the first cut to the tip of the auricular appendix. The dark venous blood should now be washed away from the interior of the auricle with a sponge.

The internal surface of the cavity presents a smooth glossy appearance, due to its endocardial lining. In the auricular appendix the wall is raised into a series of closely-applied parallel ridges called the *musculi pectinati*, from their resemblance to the teeth of a comb. These ridges are also present on the anterior wall of the auricle.

The blood enters the auricle by the following openings :—(1.) the opening of the superior vena cava; (2.) the opening of the inferior vena cava ; (3.) the opening of the coronary sinus ; (4.) the orifices of one or two anterior cardiac veins from the surface of the right ventricle ; (5.) the foramina Thebesii.

The blood flows out of the cavity, into the right ventricle, through the large auriculo-ventricular opening.

The *orifice* of the *superior vena cava* is situated at the upper part of the auricle. The *inferior vena cava* opens into the lower part of the cavity. The dissector should note that these two veins are so directed that the currents of blood, which flow from them into the auricle, shall not be opposed, the one against the other. The blood of the superior vena cava is directed towards the auriculo-ventricular opening, whilst the stream of blood flowing from the mouth of the inferior vena cava is directed so as to impinge against the septum between the auricles.

The *auriculo-ventricular* orifice is the large oval opening situated at the lower part or floor of the auricle. Through this aperture three fingers can be readily passed into the ventricle. If the student now looks between this opening and the orifice of the inferior vena cava, he will discover the mouth of the *coronary sinus*, imperfectly guarded by a fold of endocardium, which receives the name of the *coronary valve* or *valve of Thebesius*. An attentive examination of the inner surface of the auricular wall will further reveal several minute, round, irregularly-scattered openings called the *foramina Thebesii*. Some of these are simply small coecal pits in the substance of the heart, whilst others are the mouths of minute veins—the venæ Thebesii.

Examine, in the next place, the posterior wall of the right auricle. It is formed by the partition which separates the two auricles from each other. Upon this an oval depression, surrounded by a prominent ridge, will be noticed a short distance above the mouth of the inferior vena cava. The depression is called the *fossa ovalis*, and it marks the position of the foramen ovale of the fœtal heart. The ridge, which is deficient below, is crescentic in form, and is called the *annulus ovalis*. In a few cases, a communication between the two auricles may be found by slipping a probe under the upper and best-marked part of the *annulus*. Stretching between the anterior horn of the annulus ovalis and the anterior margin of the mouth of the inferior vena cava is a crescentic fold of endocardium, frequently cribriform, called the *Eustachian valve.*

Right Ventricle.—*Incisions* (Fig. 10).—(1.) A vertical incision through the anterior wall of the ventricle about a quarter of an inch to the right of the anterior interventricular furrow. Enter the knife above at the conus arteriosus, and carry it downwards, parallel to

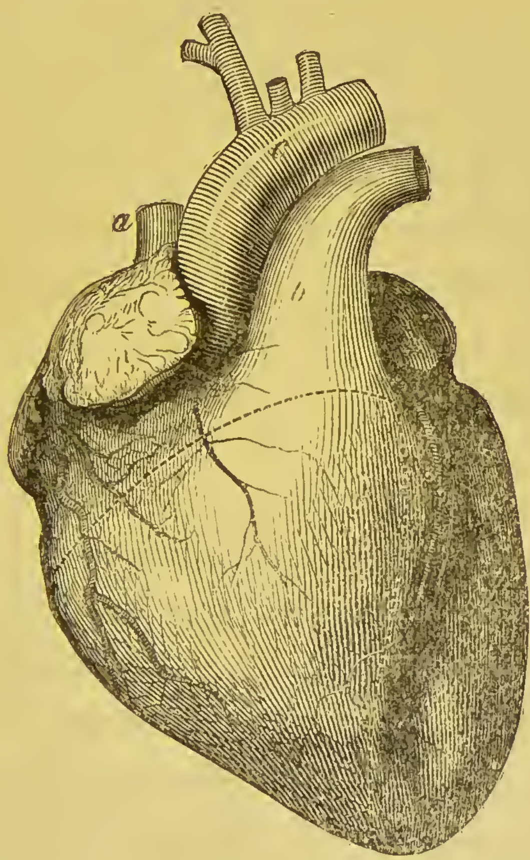


FIG. 10.

Diagram to show the manner in which the right ventricle should be opened. The dotted lines indicate the directions of the incisions. In the anterior interventricular furrow the coronary artery and the great cardiac vein are seen. *a*, Superior vena cava; *b*, Pulmonary artery ; *c*, Aortic arch.

the furrow, to the right margin of the heart. (2.) A transverse incision, through the anterior wall of the ventricle, from the upper end of the first incision to the right margin of the heart. This cut should be made parallel to the auriculo-ventricular groove, and about half-an-inch below it.

The anterior wall of the ventricle can, in this way, be raised in the form of a V-shaped flap and turned to the right. Wash away the blood and clots.

With the exception of the conus arteriosus, the interior of which is smooth and even, the inner surface of the walls of the right ventricle is rendered extremely irregular by the projection of fleshy ridges called *columnæ carneæ.* It is customary to describe these as presenting three different forms—(*a.*) Simple elongated ridges; (*b.*) fleshy slips free throughout the greater part of their extent, but fixed to the wall by their two extremities; (*c.*) conical fleshy projections of considerable size attached by their bases only, and called *musculi papillares.* The free end of each of these papillary muscles gives origin to several delicate thread-like tendons—*the chordæ tendineæ*—and by these they are brought into connection with the segments of the auriculo-ventricular valve. A transverse fleshy band will be noticed to spring from the base of the anterior papillary muscle and stretch across the ventricular cavity to the septum, to which it is attached. This is the *moderator band.* By fixing the yielding anterior wall of the ventricle to the more solid septum, it prevents over-distension of the cavity.

There are two openings in the right ventricle—(1.) The *auriculo-ventricular*, which gives admission to the stream of blood; (2.) *the pulmonary*, through which the blood passes into the pulmonary artery. Both these openings are situated at the base of the ventricle—the large oval auriculo-ventricular orifice lying to the right, close to the sharp right margin of the heart; and the pulmonary aperture being situated to the left and in front of the other at the summit of the conus arteriosus. But, further, both of these openings are guarded by valves, which act so as to give the blood its proper direction through the heart.

The *auriculo-ventricular valve*, also called *the tricuspid valve*, is composed of three triangular pointed membranous segments, termed cusps. These are united by their bases so as to form an annular membrane, and through the intermediation of this they are fixed to the fibrous ring which surrounds the auriculo-ventricular opening. In the intervals between these larger segments three smaller cusps may be detected.

Each cusp is composed of two layers of endocardium, between which there is a certain amount of fibrous tissue. This fibrous tissue is confined to the central portion of the cusp, the margins of which are therefore thin and translucent. Attached to the ventricular surface and margins of each segment are several of the chordæ tendineæ which have been seen to take origin from the apices of the papillary muscles. In consequence of this, the ventricular surface of the valve is rough, whilst the auricular surface—that surface over which the blood flows—is smooth.

It is necessary, however, to note the relative position of these cusps. One is placed in relation to the anterior wall of the ventricle; another is placed against the posterior wall; whilst the third lies to the left between the auriculo-ventricular and pulmonary openings.

The valve which guards the mouth of the pulmonary artery is composed of three semilunar segments, and is called the *semilunar* or the *sigmoid valve*. By looking upwards into the lumen of the artery a view of these segments may be obtained, but it is better to defer their examination until the vessel itself has been studied.

Pulmonary Artery.—This vessel has an oblique direction upwards, backwards, and to the left, so as to reach the lower aspect of the transverse portion of the aortic arch. It here divides into a *right* and a *left* branch. At first it lies upon the root of the aorta, but, before it terminates, it is placed upon the left side of the ascending part of the aortic arch. In relation to each side of the pulmonary artery the dissector will notice the coronary artery and auricular appendix of that side. Up to the point where it bifurcates it is included within the pericardium, the serous layer forming a single tubular sheath for it and the ascending aorta.

The *right pulmonary artery* is somewhat longer than the left. It passes transversely outwards behind the aorta and superior vena cava to reach the root of the right lung, where it has already been dissected. The *left pulmonary artery* runs outwards in front of the descending aorta and left bronchus to gain the root of the left lung. A strong fibrous cord—the obliterated *ductus arteriosus*—will be observed connecting the root of the left pulmonary artery with the under surface of the transverse portion of the aortic arch.

The pulmonary artery may now be slit open, so as to expose the *semilunar valve*, which guards its orifice. This incision must be made carefully, and the knife carried upwards through the wall in the interval between two of the segments. Each semilunar segment will be observed to be attached by its convex margin, whilst its concave margin is free. Three minute pouches are thus formed around the mouth of vessel, and the openings of these pouches are directed upwards. A good idea of the valve may be obtained by filling the pouches with cotton wadding. The segments consist of a double layer of endocardium, strengthened by intermediate fibrous tissue, and if the free margins be taken between the finger and thumb a minute nodule of cartilage may be felt about its middle. This is the *corpus Arantii.* Opposite each segment the wall of the artery shows a slight dilatation or bulging, called the *sinus of Valsalva.*

Pulmonary Veins.—The blood is conveyed back to the heart by the pulmonary veins. These have already been studied in the roots of the lungs. Two issue from each lung. The *right veins* are longer than the left, and pass inwards behind the superior vena cava, the right auricle and the ascending portion of the aortic arch. The *left veins* pass in front of the descending aorta. If the inferior vena cava be now divided and the heart turned upwards, the pulmonary veins will be seen opening into the left auricle upon its posterior aspect.

Left Auricle.—The heart must be turned well over to the right side of the body, and its apex tilted forwards. Fig. 11 shows the incision which should be made through its wall in order to display its interior. Enter

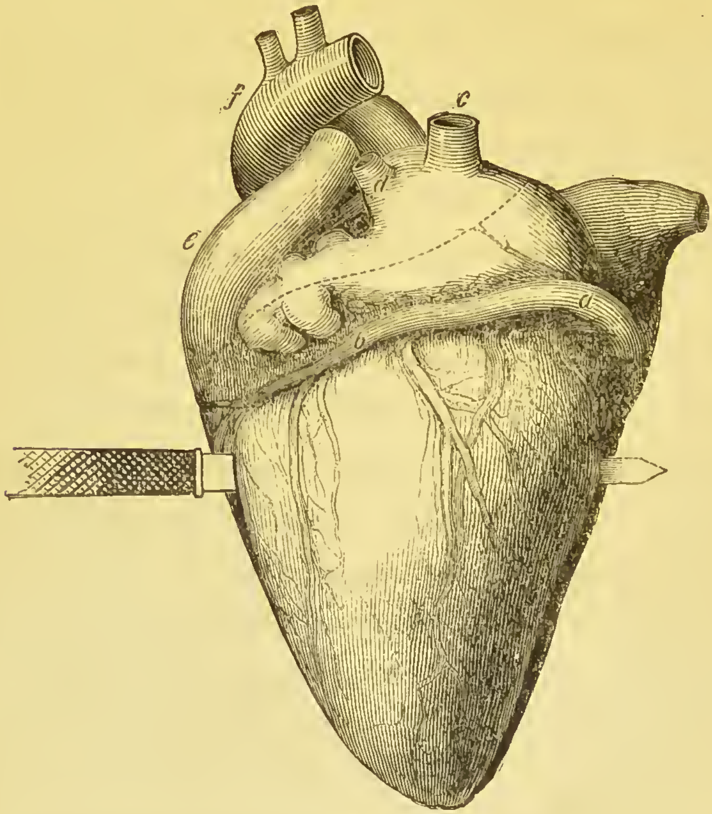


FIG. 11.

Diagram to show the manner in which the left auricle and left ventricle should be opened. The dotted line gives the direction in which the incision through the wall of the auricle should be made. *a*, Coronary sinus; *b*, Great cardiac vein; *c* and *d*, The two left pulmonary veins; *e*, Pulmonary artery; *f*, Aortic arch.

knife well back and carry it obliquely forwards into the auricular appendix. The cavity is usually more or less distended with injection, and after this has been removed and the walls washed with warm water, the student will observe that the *musculi pectinati* are confined entirely to the appendix. Everywhere else the inner surface of the walls is smooth. In the posterior wall the four openings of the *pulmonary veins* will be seen, and in the lower and fore part of the auricle is the oval *auriculo-ventricular opening*, which is wide enough to admit the passage of two fingers into the ventricle. The position of the fœtal *foramen ovale* can also be distinguished upon this side of the septum between the auricles, but it is not so well marked as it is in the right auricle.

Left Ventricle.—To open the left ventricle the dissector should stand upon the right side of the body and grasp the heart with the left hand, so that the forefinger rests upon the upper part of the posterior interventricular furrow and the thumb upon the upper part of the anterior interventricular furrow. The wall of the ventricle should next be transfixed by a long knife. (Fig. 11.) Enter the knife below the thumb, about half-an-inch to the left of the anterior furrow, and push it through the ventricular wall towards the forefinger, so that the point emerges below this and half-an-inch to the left of the posterior furrow. Now carry the knife downwards towards the apex, but never allow it to come nearer to the furrows than it was when entered. If necessary, the cut on each side may be extended upwards towards the base of the ventricle with a small knife.

When the lard injection and blood have been washed away from the interior of the left ventricle with hot water, the *columnæ carneæ* will be observed to form dense reticulations on the inner surface of its walls. The *musculi papillares*, with their attached chordæ tendineæ, are collected into two strongly-marked groups.

The left ventricle has two openings—(1.) the auriculo-ventricular opening, through which the blood flows from the auricle; (2.) the aortic orifice, through which the blood flows into the aorta. Both of these apertures are situated at the base of the ventricle, the *auriculo-ventricular* lying posteriorly and to the left, whilst the *aortic orifice* is placed anteriorly and to the right. Both openings are guarded by valves—the auriculo-ventricular opening by the *mitral* or *bicuspid valve*, and the aortic opening by the *aortic valve.*

Examine first the *mitral valve.* It consists of two large pointed cusps with two smaller portions intervening. These are similar in structure to the cusps of the tricuspid valve, but the segments are much stronger and thicker. The chordæ tendineæ from each musculus papillaris proceed to one of the two intervals between the cusps, and are attached to the adjacent margins and to the ventricular surfaces of the two cusps. Now look to the position which these cusps hold. The *anterior cusp* lies in front and to the right of the opening, being so placed as to intervene between the two apertures at the base of the ventricle. You will notice that both surfaces of this segment are smooth, for the very obvious reason, that the stream of blood flows over both. The *posterior cusp* lies behind and to the left of the opening.

Looking upwards into the mouth of the aorta, the *aortic valve* will be seen. It is similar in all respects to the pulmonary valve, only its segments are stronger and thicker, and the sinuses of Valsalva at the root of the aorta are more strongly marked.

The above details will be dry and meaningless unless they are looked at in connection with the action of the heart during life. The heart is one of those organs, the construction of which it is impossible to understand without at the same time studying its function. During life, the blood is driven through and from the heart by means of successive rhythmical contractions and dilatations of its walls. But the entire heart does not act simultaneously. First, the auricles contract together, and this is succeeded by the contraction of the ventricles; in other words, the auricular contractions correspond to the ventricular dilatations, and *vice versa*. But, again, there is a period immediately preceding the auricular contraction, during which the entire heart is at rest; and this is called the period of cardiac rest. These three conditions of the walls of the heart—viz. (*a*) the cardiac rest, (*b*) the auricular contraction, (*c*) the ventricular contraction—follow each other consecutively and without intermission, the one after the other; and they are collectively spoken of as "a cardiac revolution." Let us next study what is going on inside the heart during each of these three stages.

During the *period of cardiac rest* the auricles are filling. Blood is flowing into the right auricle through the openings of the superior vena cava, inferior vena cava, and the coronary sinus; and into the left auricle through the orifices of the four pulmonary veins. A portion of this blood trickles down through the auriculo-ventricular openings into the ventricles; but the blood is passing into the auricles in greater quantity than it is trickling into the ventricles, and the result is, distension of the auricles. The second stage of the cardiac revolution now takes place—viz., *the auricular contraction*. The auricles contract sharply and suddenly, and the blood is forced through the auriculo-ventricular orifices into the ventricles. But how is it that the blood, during this contraction, does not regurgitate into the veins, the mouths of which are devoid of valves? For the simple reason that the contraction begins at the venous orifices, and travels towards the auriculo-ventricular openings; and partly also owing to the column of blood which is already contained

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within them, and which offers a barrier to the entrance of more. The ventricles are now full, and the *third* stage of the cardiac revolution takes place—viz., *the ventricular contraction.* The ventricles contract more slowly, and, as it were, more deliberately than the auricles, and the blood is discharged into the pulmonary artery and into the aorta. Regurgitation of blood through the auriculo-ventricular openings into the auricles is prevented by the tricuspid and bicuspid valves being thrown across these openings, and regurgitation from the arteries into the ventricles by the semilunar valves being thrown across the arterial orifices.

Let us examine the mode of action of these valves. *The auriculo-ventricular valves.*—As the blood is forced from the auricle into the ventricle, it passes from a narrow channel into a wider channel, and the result is that an eddy is produced in the ventricle, and the segments of the valve are floated up so as to close the orifice. In this position they are retained, and prevented from being forced upwards into the auricle during the ventricular contraction by the musculi papillares and the chordæ tendineæ. As the ventricular wall in its contraction, to a certain extent, advances towards the auriculo-ventricular opening, the musculi papillares, in their contraction, retreat from it, and keep the tendinous cords tense—never allowing them to slacken. *The semilunar valves.*—When the contraction of the ventricle ceases, and the *vis a tergo* is removed from the blood, the recoil of the expanded wall of the artery exerts a pressure upon the column of blood. Its backward flow is prevented by the filling of the pouches of the semilunar valve.

The three stages of the cardiac revolution do not occupy equal periods of time. If we express the time taken for the complete revolution by the number 6, the period of cardiac rest would take three-sixths, the auricular contraction one-sixth, and the ventricular contraction two-sixths of the revolution.

Arch of Aorta.—The arch of the aorta should next be examined, and the various parts in relation to it dissected out. It takes origin from the base of the left ventricle opposite the *sixth dorsal vertebra.* From this point it proceeds upwards and to the right, at the same time advancing towards the sternum; reaching the upper border of the *second costal cartilage* of the *right* side, it changes its direction, passes transversely to the left, and recedes from the surface so as to gain the lower border of the left side of the *fourth dorsal vertebra.* It now bends downwards, and at the lower border of the body of the *fifth dorsal vertebra* it becomes continuous with the descending thoracic aorta.

The ascending portion of the aortic arch is enclosed within the fibrous pericardium, whilst the same sheath of serous pericardium surrounds it and the pulmonary artery. At its origin it lies under cover of the pulmonary artery, but higher up this vessel is placed to the left of the ascending aorta. To its right side is the superior vena cava, whilst behind, it is in relation to the bronchus and pulmonary vessels of the right side. The coronary arteries have already been seen to take origin from this portion of the aorta.

The *transverse part* of the aortic arch lies under cover of the left pleura, towards the left side of the body. It is also overlapped by the left lung, and crossed superficially by (*a.*) the left phrenic nerve, (*b.*) the left pneumogastric nerve, and (*c.*) between these by the two cardiac nerves which enter into the formation of the superficial cardiac plexus. In relation to its *upper surface* is the left vena innominata, and from this aspect of the vessel three large arteries take origin—viz., from right to left (*a.*) the innominate artery, (*b.*) the left common carotid artery, (*c.*) the left subclavian artery. Its *lower surface* is in relation to the bifurcation of the pulmonary artery, and is connected with the root of the left pulmonary artery by the fibrous ductus arteriosus. Hooking round this border is the recurrent laryngeal branch of the left vagus nerve. Its *posterior surface* is in relation to the trachea, œsophagus, and thoracic duct, and left recurrent laryngeal nerve.

The *descending portion* of the aortic arch lies close against the left side of vertebral column, between it and the left pleura. The œsophagus and thoracic duct lie in relation to its right side, but on a plane somewhat anterior to it.

Turn your attention, in the next place, to the three great arteries which spring from the upper surface of the transverse portion of the aortic arch.

The Innominate Artery.—The innominate artery is the largest of the three branches. It passes obliquely upwards and to the right, and, gaining the posterior aspect of the right sterno-clavicular articulation, it there ends by dividing into the right common carotid and right subclavian arteries. *In front* of the vessel is the manubrium sterni, to the posterior aspect of which are attached the sterno-hyoid and sterno-thyroid muscles. Further, the artery is crossed superficially, and close to its origin, by the left vena innominata. *Behind* is the trachea; but as the vessel inclines to the right, it comes to lie at a higher level upon the right side of the windpipe. To the *right side* of the artery are the pleura, the right innominate vein, and the right phrenic nerve. With the exception of its two terminal branches, the innominate artery is devoid of branches. The *thyroidea ima*, an occasional artery, may be seen to spring from it in some few cases.

Left Common Carotid Artery.—This artery ascends to the posterior aspect of the left sterno-clavicular articulation. At this point it leaves the thorax and enters the neck. It lies deeply in the thorax at a greater distance from the manubrium sterni than the innominate artery. *In front* of this vessel are the remains of the thymus gland, and the left vena innominata, which crosses it. *Behind*, it is in relation to the trachea, œsophagus, and thoracic duct. To its *left side* is the left vagus nerve. It gives off no branches.

Left Subclavian Artery.—Lies still more deeply within the thorax than the left carotid artery. It ascends almost vertically to the inner margin of the first rib, where it leaves the thorax and enters the root of the neck. *In front*, it is overlapped by the pleura and left lung, and is crossed by the left innominate vein. *Behind*, it rests upon the œsophagus, thoracic duct, and longus colli muscle. To its *inner* or *right side* are the trachea, left vagus nerve, and left recurrent laryngeal nerve.

Deep Cardiac Plexus.—In order to dissect this plexus of nerves it is necessary to divide the arch of the aorta at the commencement and termination of its transverse portion. Two ligatures should be applied around the vessel at each of these points and the section made between them. This is done to prevent the escape of the injection with which the artery is filled. It is well also to sever the superior vena cava immediately below the point where it is joined by the vena azygos major. By cutting the fibrous ductus arteriosus the transverse part of the arch can be drawn aside.

The *deep cardiac plexus of nerves* lies between the transverse portion of the aortic arch and the lower end of the trachea, at a higher level than the bifurcation of the pulmonary artery. It consists of a *right* and a *left* portion connected by numerous communicating filaments.

The *right part* of the deep cardiac plexus receives the following cardiac nerves:—(*a.*) the three cervical cardiac nerves of the sympathetic of the right side; (*b.*) all the cardiac nerves of the right vagus; (*c.*) a few minute twigs from the right recurrent laryngeal nerve. The branches of this portion of the plexus are distributed as follows:—(*a.*) the greater number join with twigs from the superficial cardiac plexus to form the anterior coronary plexus, which is associated with the left coronary artery; (*b.*) a few supply the right auricle; (*c.*) some offsets are sent to the right anterior pulmonary plexus; (*d.*) a few twigs go to the posterior coronary plexus.

Entering into the formation of the *left portion* of the plexus, there are—(*a.*) the two lowest cervical cardiac branches of the sympathetic of the left side; (*b.*) all the cardiac nerves of the left vagus with the exception of its lowest cervical cardiac branch; (*c.*) some offsets of the left recurrent laryngeal nerve. Its branches have the following distribution:—(*a.*) the greater number form the posterior coronary plexus, which is associated with the right coronary artery; (*b.*) some supply the left auricle; (*c.*) a few pass forwards to join the superficial cardiac plexus; (*d.*) some are continued into the left anterior pulmonary plexus.

Removal of the Heart from the Body.—To do this it is only necessary to divide the pulmonary artery and the pulmonary veins. The other vessels have been already severed. The ascending portion of the aortic arch which is attached to the heart should next be slit open, care being taken to carry the knife between two of the segments of the valve, so as not to injure either. The semilunar valve can now be studied, and the dissector will observe that two of the segments are placed anteriorly and one posteriorly in relation to the aortic orifice. On looking into the sinuses of Valsalva, which correspond to the two anterior segments, the mouths of the coronary arteries will be seen.

The last step in the dissection of the heart consists in the removal of the auricles. In effecting this, the student should observe that the muscular fibres of the auricles are not continuous with those of the ventricles. The relative positions of the ventricular openings can now be seen. The auriculo-ventricular openings lie posteriorly and side by side; the aortic opening lies in front and between them; whilst the pulmonary orifice is placed in front of the aortic opening.

Trachea and Bronchi.—The thoracic portion of the trachea lies in the middle line of the body in the superior mediastinal space. To expose it more fully separate the two pulmonary arteries with the knife, and throw each outwards towards the lung with which it is connected. Draw aside the transverse portion of the aortic arch. The trachea will now be seen to extend downwards as far as the *fourth* or *fifth* cervical vertebra, where it ends by dividing into the two bronchi. Remove the bronchial glands which occupy the angle between the bronchi.

The relations of the thoracic part of the trachea may now be studied. *In front* of it the dissector will recognise—(1.) the manubrium sterni, to the posterior aspect of which the sterno-hyoid and sterno-thyroid muscles are attached; (2.) the remains of the thymus body; (3.) the left innominate vein; (4.) the transverse portion of the aortic arch and the origins of the innominate and left common carotid arteries; (5.) the deep cardiac plexus. *Behind*, it rests upon the œsophagus, which lies somewhat to the left side. On its *right side* are the pleura and the right pneumogastric nerve; and on its *left side* are the pleura, the left pneumogastric nerve, the left recurrent laryngeal nerve, and the left common carotid artery.

The two bronchi differ greatly from each other. The *right bronchus* is shorter and wider, and almost horizontal in its course. The vena azygos major passes forwards, in contact with its upper surface, to reach the superior vena cava. The *left bronchus* is longer, narrower, and more oblique in its course. It enters the left lung fully an inch lower down in the chest than the right bronchus enters the right lung. As it passes outwards and downwards it crosses in front of the œsophagus and the descending aorta. From its postero-inferior aspect a slender muscular slip may, in some cases, be observed to take origin. This fasciculus connects it with the œsophagus, and is therefore called the *broncho-œsophageal* muscle.

The relations of the bronchi in the roots of the lungs have already been studied (*vide* p. 158).

Posterior Mediastinum.—This is the term which is applied to that portion of the interpleural space which lies between the pericardium and the bodies of the vertebræ. The following is a list of the structures which it contains :—

(1.) The thoracic aorta.
(2.) The œsophagus.
(3.) The pneumogastric nerves.
(4.) The thoracic duct.
(5.) The vena azygos major.
(6.) The vena azygos minor superior.
(7.) The vena azygos minor inferior.
(8.) The great splanchnic nerves.
(9.) Some lymphatic glands.

To open into the space it is necessary to make a vertical incision through the pericardium, which forms its anterior wall. Carry the knife along the line of the œsophagus, and throw the pericardium outwards and inwards. If this be done with care, a fleshy band may, in some cases, be observed crossing the superficial aspect of the thoracic aorta, and extending from the œsophagus to the pleura, which forms the left lateral wall of the posterior mediastinal space. This is the *pleuro-œsophageal muscle*. In the majority of cases, however, this muscle is only represented by a few slender muscular fasciculi, which are difficult to isolate from the areolar tissue in which they lie.

Pneumogastric Nerves.—The pneumogastric nerves can now be followed throughout their entire course within the thorax. They differ so much in their relations on the two sides of the body that it is best to examine each separately.

The *left pneumogastric* nerve enters the thorax in the interval between the left common carotid and left subclavian arteries, and behind the left innominate vein. It has already been observed crossing the arch of the aorta upon the left side of the phrenic nerve and the two superficial cardiac nerves. Here also it has been seen to give off its recurrent laryngeal branch. Leaving the aorta, it sinks behind the root of the left lung, and at once breaks up into a number of branches, which unite in a plexiform manner to form the *left posterior pulmonary plexus.* It issues from this plexus in the form of one or two nervous cords, which pass to the anterior aspect of the œsophagus. Upon the œsophagus another plexus—the *plexus gulæ*—is formed ; but this plexus differs from the pulmonic plexus, inasmuch as the pneumogastric nerves of both sides take part in its formation. From the plexus gulæ the left pneumogastric emerges as one nervous cord, and passes out of the thorax by the œsophageal opening of the diaphragm. It is distributed within the abdomen upon the anterior surface of the stomach.

The *right pneumogastric nerve* lies deeper in the thorax than the left nerve. It enters by passing between the subclavian artery and the right innominate vein, and descends by the side of the trachea to the posterior aspect of the root of the right lung. Here it breaks up into the *right posterior pulmonary plexus*, and, issuing from this in the form of two nervous cords, it takes part in the formation of the *plexus gulæ*. It leaves this plexus upon the posterior aspect of the œsophagus, and, entering the abdomen through the œsophageal opening of the diaphragm, it is distributed to the stomach upon its posterior surface.

The pneumogastric nerves give off the following branches within the thorax :—

(1.) Recurrent laryngeal.
(2.) Thoracic cardiac.
(3.) Pulmonary.
(4.) Œsophageal.

The *left recurrent laryngeal* nerve springs from the pneumogastric as it crosses the arch of the aorta. It hooks round the transverse part of the aortic arch, and reaching the trachea, ascends by the side of this to the larynx. The *right recurrent laryngeal* nerve arises in the root of the neck, and hooks round the subclavian artery.

The *thoracic cardiac* branches of the right side proceed in part from the pneumogastric and in part from the recurrent laryngeal nerve of that side. On the left side of the body they are derived from the left recurrent laryngeal nerve.

The *pulmonary branches* have already been studied in connection with the root of the lung (*vide* p. 157).

The *œsophageal branches* are dispensed to the gullet in two sets—(1.) a few delicate twigs are given by the pneumogastric before it enters the pulmonary plexus to that portion of the œsophagus which lies in the superior mediastinum; (2.) numerous filaments are supplied by the plexus gulæ to that part of the œsophagus which is placed in the posterior mediastinum.

Œsophagus.—The thoracic portion of the œsophagus should next be studied. It lies partly in the superior mediastinum and partly in the posterior mediastinum. It is the narrowest, but at the same time the most muscular, part of the alimentary canal. It descends in front of the spine, following its antero-posterior curvatures, and leaves the thoracic cavity opposite the ninth dorsal vertebra by passing through the œsophageal opening of the diaphragm. The œsophagus does not pursue a straight course through the thorax. It enters somewhat to the left of the middle line, but on tracing it downwards, it will be noticed to incline inwards so as to assume a mesial position opposite the fifth dorsal vertebra. From this it again deviates to the left so as to gain the œsophageal opening in the diaphragm. From above downwards you will notice the following structures in contact with the œsophagus *in front:* (1.) the trachea; (2.) the left bronchus; (3.) pericardium. *Behind*, it rests from above downwards: (1.) upon the longus colli muscle opposite the first two dorsal vertebræ; (2.) upon the bodies of the vertebræ and the intercostal arteries; (3.) upon the anterior aspect of the thoracic aorta. Upon *the right side* it is related to the right pleura and the vena azygos major; whilst on the *left side* are the pleura and the thoracic aorta, except in its lower part, where the œsophagus lies in front of the vessel. Lastly, bear in mind that the pneumogastric nerves form the plexus gulæ upon its walls.

The Thoracic Aorta.—The thoracic aorta is the direct continuation of the aortic arch. It begins at the lower border of the fifth dorsal vertebra, and ends opposite the last dorsal vertebra by entering the abdomen through the aortic opening of the diaphragm, and becoming the abdominal aorta. At its commencement it lies somewhat to the left of the middle line, but as it proceeds downwards it inclines inwards, so that at its termination it is mesial in position. It lies upon the bodies of the vertebræ, and therefore it shows a curve corresponding to that of the vertebral column in the dorsal region. *In front*, it is covered by the pericardium, and is crossed by the root of the left lung. *Behind*, it rests upon the vertebral bodies and the intervening intervertebral discs, whilst crossing behind it the dissector will observe the vena azygos minor inferior, and, in many cases, the vena azygos minor superior. To *the left side*, and closely applied to the vessel, is that part of the pleura which forms the left lateral wall of the posterior mediastinum; whilst on *its right side* will be noticed the thoracic duct and the vena azygos major.

The œsophagus has a varying and important relationship to the thoracic aorta. At first it lies to the *right* of the aorta, but as it approaches the diaphragm, it inclines to the left and comes to lie *in front* of the vessel; and lastly, before it passes through the œsophageal opening of the diaphragm, it is somewhat to its *left side.*

The branches of the thoracic aorta may be grouped under the heads of *visceral* and *parietal.*

Visceral.	Bronchial. Pericardiac. Œsophageal. Posterior Mediastinal.
Parietal.	Intercostal (nine on each side).

The *bronchial arteries* are usually three in number —*two* for the left lung and *one* for the right lung. They are very variable in their manner of origin. The *right* bronchial artery often springs from the first aortic intercostal artery. They run upon the posterior aspect of the corresponding bronchus, and they have already been studied as constituent parts of the roots of the lungs. The *pericardiac* branches are some minute twigs which are distributed to the posterior aspect of the pericardium. The *œsophageal* arteries are the vessels of supply to the gullet. They are four or five in number, and are irregularly placed. They spring from the front or right side of the aorta, and form a chain of anastomoses on the wall of the œsophagus. Above, this chain communicates with branches of the inferior thyroid artery, whilst below it communicates with the ascending branches of the coronary artery of the stomach. The *posterior mediastinal* branches are very small, and are given to the areolar tissue and glands in the posterior mediastinal space.

The *intercostal branches* will be observed arising in pairs from the posterior aspect of the aorta. Defer their examination, however, until the thoracic duct and the sympathetic cord have been dissected.

The Thoracic Duct.—The thoracic duct, although a vessel of small calibre, is a highly important duct. It receives all the lymphatic vessels of the body below the diaphragm, the lymphatics of the left side of the chest (including the left lung and left side of the heart), and the lymphatics of the left superior extremity and left side of the head and neck. It will be found by dissecting in the loose areolar tissue which lies between the aorta and the vena azygos major. Its diameter is not much greater than whip-cord, and it will be recognised from its position and by the great elasticity which it exhibits when it is pulled by the forceps. Trace it downwards, and it will be found to enter the thorax upon the right side of the aorta, and through the same opening in the diaphragm. It commences within the abdomen upon the second lumbar vertebra in a dilatation called the *receptaculum chyli*. Follow it upwards, and you will notice that it gradually inclines to the left. At the level of the fourth dorsal vertebra it passes behind the aortic arch and œsophagus. It now ascends to the neck between the œsophagus and left pleura, and ends by joining the internal jugular vein at its point of union with the subclavian vein. As it passes upwards through the thorax, the thoracic duct pursues a somewhat wavy or flexuous course. It frequently breaks up into two or more branches, which unite again to form a single trunk. It is provided at intervals with valves of two segments, and these, when the duct is injected, give it a beaded or nodulated appearance. The valves are more especially numerous in the upper part of the duct.

Removal of Lungs.—The lungs may now be removed by dividing the trachea about an inch above its bifurcation. An examination of the trachea and bronchi will show that they are not uniformly cylindrical tubes, but that they are flattened posteriorly. At first sight the cartilaginous rings which are embedded in the external fibro-elastic coat appear to describe complete circles around the tubes. This is not the case, however; the rings are deficient behind, and are therefore horse-shoe shaped. The posterior third of both trachea and bronchi is entirely membranous and muscular in its structure.

The bronchi should be traced into the lungs and their manner of subdivision studied. As a general rule, they branch dichotomously, but in some few cases a tube may be seen to end by dividing into three, and it is by no means uncommon to observe one or more collateral branches springing from the side of a main trunk. Within the pulmonary substance the tubes become cylindrical, and the student will not fail to notice that the cartilaginous rings have now broken up into bars and flakes, which are scattered irregularly around walls of the tubes. The further he traces the tubes into the lung, the scarcer and finer will these cartilaginous flakes and nodules become.

Gangliated Cord of the Sympathetic.—The dissector should next turn his attention to the thoracic portion of the sympathetic nervous system. In order to expose it he must strip the parietal pleura from the sides of the vertebræ and the inner surface of the ribs. He will then observe the gangliated cord extending through the thoracic cavity. It lies upon the heads of the ribs and the intervening intercostal spaces and has an appearance somewhat similar to a knotted string. It requires considerable care to make a good dissection of the various ganglia and their branches. The thoracic ganglia are usually twelve in number, and, with the exception of the two lowest, they are placed one upon the head of each of the upper ten ribs. Towards the diaphragm the cord inclines forwards, so that the two lowest ganglia come to lie upon the bodies of the two last dorsal vertebræ. The first ganglion is considerably larger than those which succeed it, and they are all linked together by intervening nervous cords. Superiorly, the thoracic part of the sympathetic is continuous with the cervical sympathetic; whilst inferiorly, it becomes continuous with the abdominal portion of the sympathetic by passing behind the ligamentum arcuatum internum of the diaphragm.

The branches which spring from the ganglia may be divided into an *external* and an *internal* series.

The *external* series are branches of communication between the ganglia and the intercostal nerves. Two run between each nerve and the corresponding ganglion. These differ in the kind of fibres which compose them. One is chiefly composed of white cerebro-spinal nerve-fibres, the other is mainly formed of grey sympathetic nerve-fibres. Through the agency of these two twigs, then, an interchange of fibres takes place between the intercostal nerve and the sympathetic ganglion.

The *internal* series are branches of distribution. From the *upper five* or *six* ganglia the internal branches go to thoracic viscera, whilst in the case of the *lower six* ganglia, the internal branches unite to form the splanchnic nerves which are destined for the supply of abdominal viscera. The *thoracic twigs* of supply are very small, and are given to the aorta, to the vertebræ and their ligaments, and to the lungs. The pulmonary branches proceed from the third and fourth ganglia, and they enter the posterior pulmonary plexus. *The splanchnic nerves* are three in number, and are distinguished by the terms *great*, *small*, and *smallest*.

The *great splanchnic nerve* is formed by the union of five roots derived from the sixth, seventh, eighth, ninth, and tenth ganglia. This description, however, must be regarded as being somewhat arbitrary, as there is great variability in the number and manner of origin of the roots of this nerve. It is said that under certain circumstances filaments may be followed upwards upon the sympathetic cord as high as the third or even the first ganglion. The great splanchnic has more the appearance of a cerebro-spinal nerve than a sympathetic nerve, owing to the large amount of spinal nerve-fibres which it contains. It passes downwards upon the bodies of the vertebræ, and leaves the thorax by piercing the crus of the diaphragm. Within the abdomen it ends by joining the semilunar ganglion.

Upon the last dorsal vertebra, a ganglion called the *great splanchnic ganglion* will in all probability be found in connection with the great splanchnic nerve. This ganglion is usually of small size, involving only a very few of the anterior fibres of the nerve. Sometimes, however, it causes a distinct oval bulging on the nerve-trunk. A few slender filaments are given by the ganglion to the coats of the aorta, and these in some cases may be made out to communicate across the middle line of the body with the corresponding branches of the ganglion of the opposite side.

The *small splanchnic nerve* arises by two roots from the tenth and eleventh thoracic ganglia. It enters the abdomen by piercing the crus of the diaphragm, and it ends by joining the solar plexus.

The *smallest splanchnic nerve* is a minute twig which takes origin from the twelfth thoracic ganglion. It pierces the diaphragm, and ends in the renal plexus. It is often absent, and then its place is taken by one or more filaments from the small splanchnic nerve.

Thoracic Wall.—The thoracic wall should now be studied from within. Certain facts which have previously been stated regarding it can now be verified (*vide* p. 144). The *internal intercostal* muscle, in each space, will be seen to extend backwards as far as the angles of the ribs. At this point it stops abruptly, and the muscular stratum gives place to a thin membranous fascia, called the *posterior intercostal membrane*, which stretches from the sharply-defined posterior margin of the internal intercostal muscle to the spine.

The *subcostal muscles* are also displayed. They are small fleshy fasciculi placed upon the lower ribs, internal to their angles. The muscular fibres which compose them have the same direction as the internal intercostal muscles, but they extend over one or two intercostal spaces.

Remove the posterior intercostal membrane from one or two of the spaces, and the subjacent *external intercostal* muscles will be brought into view. These muscles reach backwards as far as the tubercles of ribs. Interposed between each of these muscles and the posterior intercostal membrane the dissector will observe the intercostal vessels and nerve.

Intercostal Arteries and Nerves.—The *aortic intercostal* arteries have already been seen taking origin from the thoracic aorta. One is given to each of the nine lower intercostal spaces upon both sides of the body. As the aorta lies somewhat to the left of the middle line, the *right* aortic intercostal arteries are longer than those of the left side. In both cases they run outwards over the bodies of the vertebræ, and under cover of the gangliated cord of the sympathetic. On the right side the arteries also pass under cover of the œsophagus, the thoracic duct, and the vena azygos major. As they leave the vertebral column to enter the intercostal spaces, each of the vessels gives off a large *dorsal branch* which passes backwards in the interval between the transverse processes and is distributed to the muscles and skin of the back. From this branch a few twigs are supplied to the spinal cord and its membranes through the intervertebral foramen. In each space the intercostal artery proceeds outwards, first lying between the posterior intercostal membrane and the external intercostal muscle, and afterwards between the two muscular strata. Each artery is accompanied by a nerve and a vein. The vein usually occupies the *highest* level, the nerve the *lowest* level, whilst the artery is *intermediate*. The distribution of these vessels in the thoracic parietes has already been studied (*vide* p. 146).

The intercostal arteries which supply the *two highest* intercostal spaces are derived from the *superior intercostal* artery of the subclavian. The superior intercostal artery descends upon the necks of the first two ribs, and external to the gangliated cord. It anastomoses with the first aortic intercostal artery, and sends outwards two vessels for the two highest spaces. Each of these, in turn, gives off a *dorsal branch* similar to the dorsal branches of the aortic intercostal arteries.

The *intercostal nerves* pass outwards in company with the arteries. The communicating twigs which pass between these nerves and the sympathetic ganglia have already been noted. Each nerve lies at a lower level than the corresponding artery, and is at first placed between the posterior intercostal membrane and the external intercostal muscle, and then between the two muscular strata. The further course of these nerves is described at p. 144.

The *first dorsal* nerve will be found passing upwards over the neck of the first rib to join the brachial plexus. It gives a small twig to the first intercostal space, but this nerve, although it is disposed after the manner of an intercostal nerve, furnishes no lateral cutaneous branch. The *second dorsal* or *intercostal* nerve almost invariably sends a branch upwards over the neck of the second rib to join that portion of the first dorsal nerve which enters the brachial plexus (Fig. 1). As a general rule, this communicating twig is exceedingly minute and insignificant, but sometimes it is a large nerve; and, in these cases, the intercosto-humeral nerve, or lateral cutaneous branch of the second intercostal nerve, is very small or altogether absent.

Veins of the Thoracic Wall.—When the dissector has traced the *intercostal veins* to their various destinations, he will find that they differ in their arrangement upon the two sides of the body. On the *right side* they terminate in three different ways :—

(1.) The intercostal vein of the first or highest space joins the *right innominate vein* (sometimes the *vertebral vein*).

(2.) The intercostal veins of the second and third spaces (and sometimes of the fourth space) unite into a common trunk, which joins the upper part of the *vena azygos major*.

(3.) The intercostal veins of the eight lower spaces join the *vena azygos major*.

On the *left side* of the body *four* modes of termination may be recognised :—

(1.) The intercostal vein of the first or highest space has the same termination as the corresponding vein of the right side. It joins the *left innominate vein* (sometimes the *vertebral vein* of its own side).

(2.) The intercostal veins of the second and third spaces (and sometimes of the fourth space) converge, and by their union form a single trunk which crosses the arch of the aorta and joins the *left innominate vein* independently of the superior intercostal vein.

(3.) The intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces terminate in the *vena azygos minor superior.*

(4.) The intercostal veins of the ninth, tenth, and eleventh spaces join the *vena azygos minor inferior.*

The azygos veins which thus receive the blood of the great majority of the intercostal veins should now be studied.

Vena Azygos Major.—This vein takes origin within the abdomen in some of the ascending branches of the right lumbar veins. It also frequently communicates with the right renal vein. It enters the thorax through the aortic opening of the diaphragm, lying upon the right side of the thoracic duct and the aorta. In the thorax it extends upwards upon the bodies of the dorsal vertebræ and over the right intercostal arteries, until it reaches the level of the upper border of the root of the right lung. At this point it hooks forwards over the right bronchus, and ends by joining the superior vena cava. It is situated in the posterior mediastinum, with the aorta lying to the left and the thoracic duct occupying the interval between them.

The *tributaries* of the vena azygos major are as follows:—(1.) the intercostal veins of the *ten* lower spaces of the right side; (2.) the vena azygos minor superior; (3.) the vena azygos minor inferior; (4.) the bronchial vein from the right lung; (5.) certain of the œsophageal veins.

The vena azygos major communicates below with some of the lumbar veins—tributaries of the inferior vena cava; whilst above, it pours its blood into the superior vena cava. In this way it forms a link by which the superior vena cava is brought into connection with the inferior vena cava.

Vena Azygos Minor Superior.—This vein is formed on the left side of the body by the union of the intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces. It communicates above with the vein which carries the blood from the second and third intercostal spaces to the left innominate vein. At the level of the eighth dorsal vertebra, it turns inwards behind the aorta and thoracic duct, and crossing the middle line, it ends by joining the vena azygos major.

The Vena Azygos Minor Inferior.—This vein takes origin within the abdomen from one of the lumbar veins of the left side. It enters the thorax by piercing the left crus of the diaphragm, and is continued upwards upon the vertebral column as far as the ninth dorsal vertebra. At this point it turns to the right, and crossing behind the aorta and thoracic duct it joins the vena azygos major independently of the vena azygos minor superior.

The tributaries of this vein are the intercostal veins of the three lower spaces of the left side.

The veins of the thoracic parietes are extremely variable, and the above description of them must be looked upon as merely representing their most usual arrangement.*

The student should now complete the dissection of the thorax by an examination of the vertebral and costo-vertebral ligaments.

* This description of the intercostal veins will be found to differ materially from that given by other text-books of anatomy. B. G. Morison, by a large number of dissections, has proved the above arrangement to be the one most commonly met with (*vide Journal of Anatomy and Physiology*, 1879).

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THE

DISSECTOR'S GUIDE:

BEING

A MANUAL FOR THE USE OF STUDENTS.

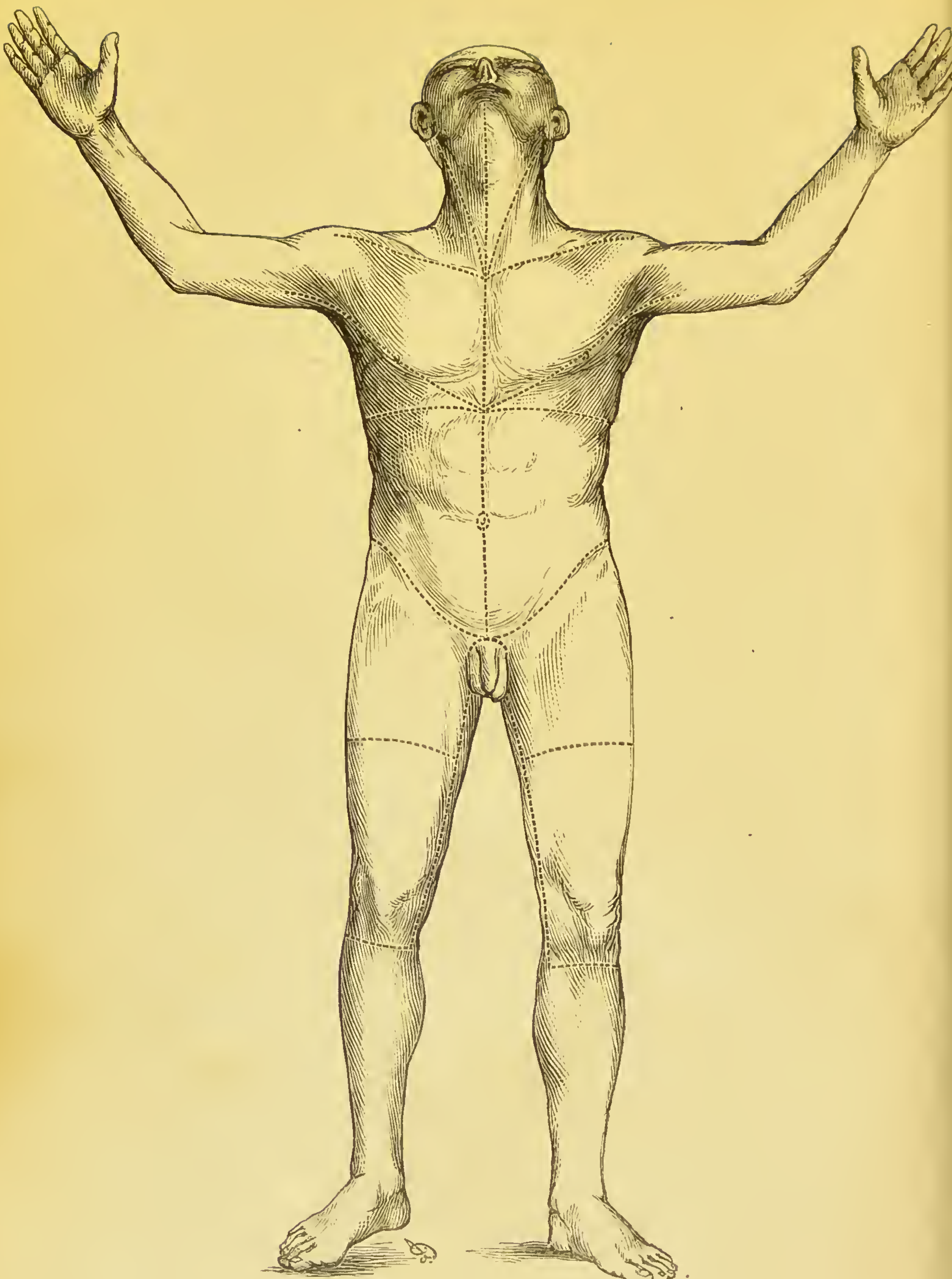

PLATE I.

THE

DISSECTOR'S GUIDE:

BEING

A MANUAL FOR THE USE OF STUDENTS.

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ABDOMEN.

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PREFACE.

THE universal criticism upon Part I. of this book has been that it is too brief. Whilst preparing it, the Author was aware that it erred on the side of brevity, but so many excellent text-books on practical anatomy were already in the field, that he was averse to enter into competition with them. His object was to provide a book which, taken in conjunction with one of these, would enable the student to dissect and learn his part, in accordance with the methods followed in the Edinburgh School. But experience has shown that this subjects the dissector to great inconvenience, inasmuch as he has constantly to refer from one book to another. For this reason the Author has deemed it necessary to make the present Part a complete text-book upon the Practical Anatomy of the Abdomen. In carrying out this arduous task, he has received great encouragement and many valuable suggestions from Professor Turner.

It has always been the opinion of the Author that

ERRATA.

Page 41, lines 1 and 2—read, "the *posterior* lip is the longer of the two, whilst the *anterior* lip is the thicker."

Page 59, line 21—add to this line, "and also from the aortic intercostal arteries."

Page 130, line 23—instead of *gastro-hepatic* read "*gastro-colic.*"

Page 227, line 21—include also under the heading of NERVES the "*sacro-coccygeal plexuses.*"

Page 254, line 4—instead of *Prostate* read "*Prostatic.*"

Page 265, line 18—instead of *Internal pudic vein* read "*Internal iliac vein.*"

ABDOMEN.

WHEN the body is brought into the Rooms, it is first placed in the lithotomy position (Pl. II.) A stout cord or bandage is doubled and passed in the form of a running noose over each hand of the subject, so as to grasp the wrist when tightened. The hands are then drawn downwards and the feet upwards until the palm of each hand rests upon the outer aspect and dorsum of the corresponding foot. In this position they must be securely fixed by passing the cord once or twice round the instep, and then tying a knot upon the inner aspect of the foot. The subject must now be drawn towards the end of the table until the breech projects slightly over the edge. A block is introduced under the pelvis, and the cords carried downwards and fastened on each side to the leg of the table, so as to keep the lower limbs well apart from each other. A third cord must next be passed behind the flexed knee-joints, and then round the neck of the subject, and tightened so as to flex the thighs upon the abdomen. In this position the body is retained for *one* day, and during this time the dissector of the abdomen is expected to dissect the *perineum*. The time allotted for this important dissection is somewhat limited, but it must be borne in mind that the lithotomy posture admits of no other dissection being done, and consequently the other dissectors are unable to begin work until the position of the body is changed.

MALE PERINEUM.

To prepare the part for dissection, a staff should first be introduced into the bladder. The rectum should then be *moderately* distended with tow, and the orifice of the anus stitched up.

In passing the staff into the bladder, the dissector must stand upon the *left* side of the subject. Having smeared the instrument with oil, hold it lightly in the right hand and guide it gently along the upper and right wall of the urethra. When the point of the instrument reaches the triangular ligament—a strong aponeurotic structure which is stretched tightly across the pubic arch—depress the handle, but use no force. Should any difficulty be experienced, introduce the forefinger of the left hand into the rectum to guide the point of the instrument along the membranous and prostatic portions of the urethra. The most dependent part of the scrotum should now be stitched to the prepuce of the penis, and dragging both penis and scrotum forwards upon the staff, they should be fixed by means of the twine to its handle. Lastly, fasten the handle of the staff to the cord which passes behind the flexed knee-joints of the subject.

Boundaries of the Perineum.—The perineal space may be said to correspond to the inferior aperture or outlet of the pelvis. It is absolutely necessary, then, that the student should renew his acquaintance with this part of the skeleton before he begins the dissection. Let him obtain a pelvis with the ligaments *in situ.* He will observe that he has to deal with a diamond-shaped space, and that it has the following boundaries: *in front*, the symphysis pubis and the subpubic ligament; *behind*, the coccyx; and *on each side* from before

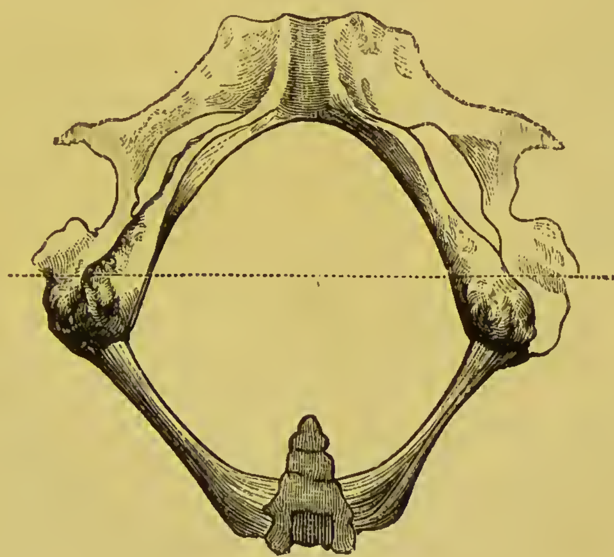


FIG. 1.
Outlet of Pelvis.

backwards, the rami of the pubis and ischium, the tuberosity of the ischium and the great sacro-sciatic ligament. If he now turns his attention to the subject before him he can readily identify these limits. The great sacro-sciatic ligament, however, is somewhat obscured, from its being covered by the gluteus maximus muscle, but it can be felt by pressing deeply in a line between the ischial tuberosity and the coccyx.

In the undissected body the superficial area of the perineum is very limited; indeed, when the limbs are extended and approximated, it merely consists of a narrow groove running forwards between the thighs from the coccyx towards the pubis. In this groove are placed the anus or orifice of the rectum and the roots of the scrotum and penis, whilst in the middle line a cutaneous ridge—the *median raphe*—may be observed. This raphe can be traced from the anus forwards over the scrotum and along the under surface of the penis.

The perineal space, then, has a diamond-shaped form, and it is customary to subdivide it arbitrarily into two portions by drawing an imaginary transverse line between the anterior parts of the ischial tuberosities and immediately in front of the anus. Two triangles are thus mapped out. The anterior of these may be appropriately called the *urethral triangle*, because the most important object which it contains is the urethra; the posterior may be distinguished as the *rectal triangle*, from its containing the lower end of the rectum.

Reflection of Skin.—Two incisions are required:—(Pl. II.) (1.) a transverse incision along the line which separates the *rectal* from the *urethral* triangle—*i.e.*, in front of the tuberosities of the ischium; (2.) an incision at right angles to this in the line of the median raphe. This incision should begin well forwards on the scrotum and be continued back a little beyond the point of the coccyx. At the anus the knife should be carried round it so as to encircle it.

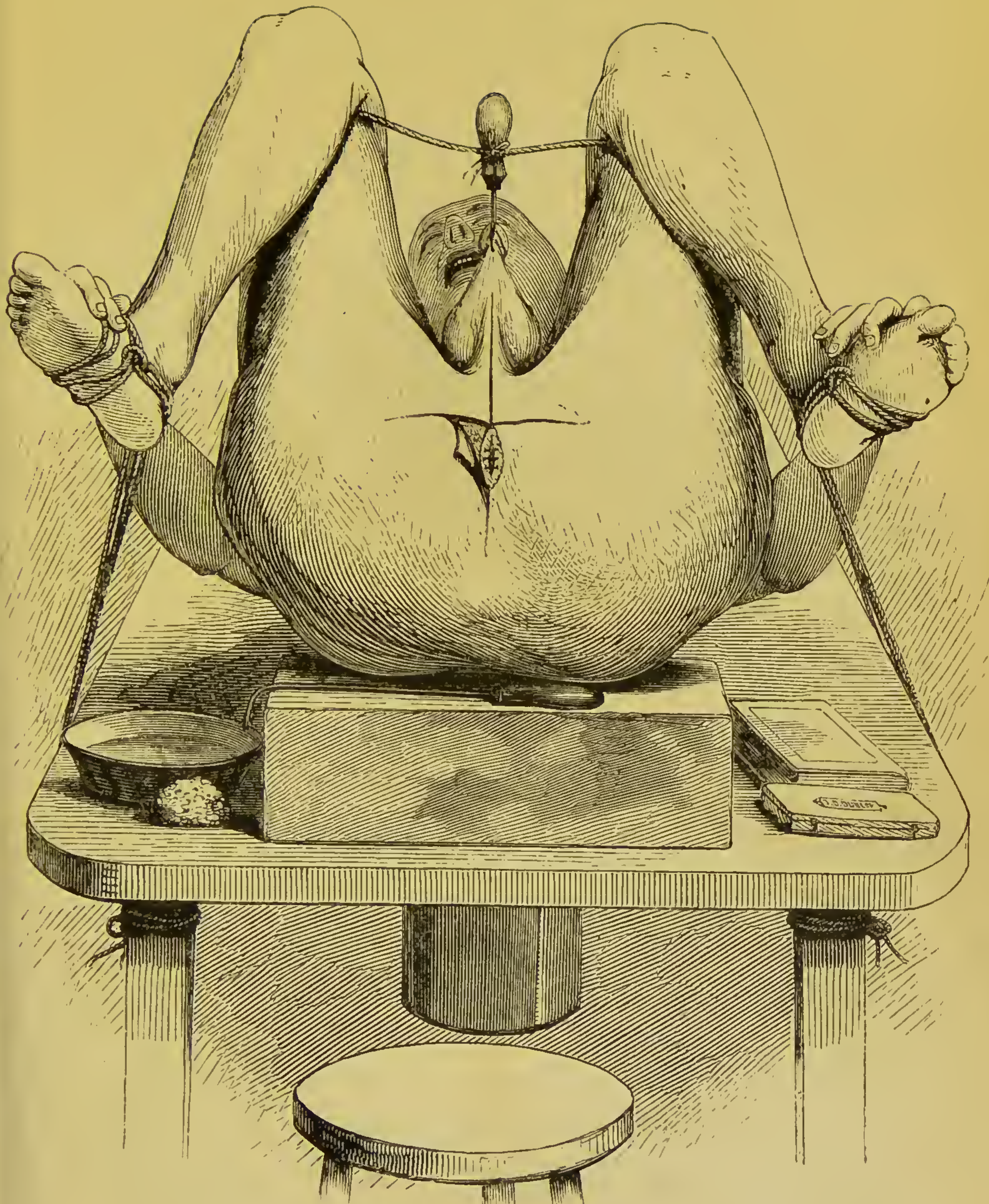


PLATE II.

The four triangular flaps which are marked out should now be raised. The *superficial fascia* and the *external sphincter muscle* are thus exposed.

Rectal Triangle.

The dissection of this portion of the perineal space will disclose the following parts (Fig. 3, p. 12) :—

(1.) The superficial fascia.
(2.) The external sphincter ani muscle.
(3.) The lower part of the rectum covered by the levator ani muscle and the anal fascia.
(4.) The parietal or obturator layer of pelvic fascia.
(5.) The lower border of the gluteus maximus muscle and the great sacro-sciatic ligament.
(6.) The coccygeus muscle.
(7.) The inferior hæmorrhoidal vessels and nerves.
(8.) The perineal branch of the fourth sacral nerve.
(9.) The commencement of the posterior superficial perineal nerve.

Superficial fascia.—The student should examine the superficial fascia as it is spread over the entire extent of the perineal space. It shows great differences in character and texture in different positions. At the side of the anus it is remarkable for the large quantity of fat it holds in its meshes. This fat is soft and lobulated, and passes upwards upon each side of the rectum in the form of a pliable and elastic pad. Over the tuberosities of the ischium the superficial fascia undergoes a striking alteration. Here it becomes tough and stringy; dense fibrous septa separate the lobules of fat from each other and connect the skin with the subjacent bone. Make an incision into it with the knife, and one or more bursæ will be displayed intervening between the fascia and bone. These bursal sacs are frequently intersected by strong fibrous bands or cords. In this locality the superficial fascia acts as a cushion on which the tuber ischii rests when the body is in the sitting posture.

But, again, if the superficial fascia be now followed forwards over the urethral triangle, another change in its character becomes manifest. The further forwards we proceed, the scarcer becomes the fat which it contains in its meshes, and in the scrotum the fat entirely disappears and gives place to a thin layer of involuntary muscular fibres. These constitute the *dartos muscle*, and are recognised by their ruddy colour. The rugosity of the scrotal integument is caused by the contraction of these fibres.

In the anterior part of the perineum the superficial fascia possesses certain very definite attachments. To elucidate these it is customary for anatomists to consider that it consists of two layers—a superficial fatty stratum and a deep membranaceous stratum. It is very true that towards the skin this fascia is usually fatty, whilst its deeper surface appears more condensed and aponeurotic, still it is anatomically one structure, and its separation into layers is more or less artificial. The attachments of the superficial fascia are effected by its deep surface, and are the following:—(1.) *upon each side* to the anterior lip of the rami of the pubis and ischium; (2.) *inferiorly* to the base of the triangular ligament. A pouch is thus formed, which is bounded *in front* by the superficial fascia, *behind* by the triangular ligament, *laterally* by the attachment of these to the sides of the pubic arch, whilst *below* it is closed by the union of the fascia with the base of the triangular ligament (Fig. 3, p. 12). Within this pouch certain very important parts are placed—viz., the superficial perineal muscles, vessels, and nerves, the bulb and crura of the penis, and the termination of the pudic artery. It is partially divided into two lateral parts by a median septum, which dips backwards from the superficial fascia. This septum is very perfect posteriorly, but becomes incomplete towards the scrotum.

The student can verify these facts in two ways—viz., (1.) by inflating the pouch with air, and (2.) by dissection. Make a longitudinal incision, large enough to admit the nozzle of the bellows, into the superficial fascia towards the back part of the pouch and a little to one side of the middle line. This cut must be carried through the fascia until the fibres of the superficial perineal muscles are exposed. In using the bellows, the margins of the opening into the pouch must be held tightly around its nozzle. You will notice that the air which is introduced passes forwards, and that it is first confined to one side of the pouch. Reaching the scrotum, however, where the septum is incomplete, it forces its way across the middle line, and inflates the opposite side of the pouch. The pouch is now rendered prominent, and the attachments of the fascia become very evident. The air cannot pass into the rectal triangle owing to the union of the superficial fascia to the base of the triangular ligament; it cannot pass down the inner aspect of the thighs from the attachment of the fascia to the sides of the pubic arch; it can only force its way forwards under the superficial fascia and dartos muscle of the scrotum, and from this on to the penis and along the spermatic cords to the anterior aspect of the abdomen. By this means the dissector obtains a very striking view of the course which would be taken by urine escaping from a rupture in the urethra in front of the triangular ligament.

The attachments of this fascia are so important that the student should also test them by dissection. To do this it is necessary to make two incisions through the superficial fascia. Enter the knife in the middle line at the root of the scrotum, and carry it backwards and outwards to the tuber ischii on each side of the body. A central Λ shaped flap and two lateral flaps of fascia are thus marked out. By raising and turning backwards the central portion, the septum of the pouch is brought into view, and the attachment of the fascia to the base of the triangular ligament is demonstrated, and by throwing each lateral flap outwards it will be seen to be firmly fixed to the side of the pubic arch. In effecting this dissection the utmost care is demanded on the part of the student. In the areolar tissue immediately subjacent to the superficial fascia are the *superficial perineal vessels and nerves*, which are certain to be injured, or perhaps even reflected with the fascia, unless the greatest caution be exercised.

Sphincter ani Externus.—When this muscle is cleaned it will be seen to consist of a thin stratum of muscular fibres surrounding the orifice of the rectum. *Behind* it is attached to the tip of the coccyx and to the recto-coccygeal ligament; *in front* it is fixed to the central point of the perineum. The fibres, in passing between these two points of attachment, encircle the anal orifice and constitute a true sphincter muscle. It draws its nervous supply from two sources—viz., *the fourth sacral nerve* and the *inferior hæmorrhoidal nerve.*

Ischio-rectal Fossa.—Although the rectum is the largest and most important object which is contained within the posterior portion of the perineum, it does not fill up the entire extent of the rectal triangle. An interval or recess is left upon each side of the rectum—between it and the ischium—and to this recess is given the name of the *ischio-rectal fossa* (Fig. 3, p. 12).

In shape the ischio-rectal fossa is pyramidal, the apex of the pyramid being directed upwards towards the pelvic cavity, and the base downwards towards the integuments.

Boundaries.—Whilst the term "*ischio-rectal*" is applied to this fossa, it must be borne in mind that neither the ischium nor the rectum enter directly into the formation of its walls. Both are separated from the space by fascial and muscular layers. Upon the inner aspect of the ischium is the obturator internus muscle, and this again is covered by the parietal or obturator layer of the pelvic fascia as it is continued down to be attached to the tuberosity of the ischium and the great sacro-sciatic ligament. On the other hand, the rectum is clothed from without inwards by—(1.) the anal fascia, a thin aponeurotic membrane which invests the outer surface of the levator ani ; (2.) by the levator ani muscle ; and (3.) by the rectal portion of the visceral layer of the pelvic fascia (Fig. 2). Strictly speaking, therefore, the *outer* or *ischial wall* of the fossa is formed by the parietal layer of the pelvic fascia, and

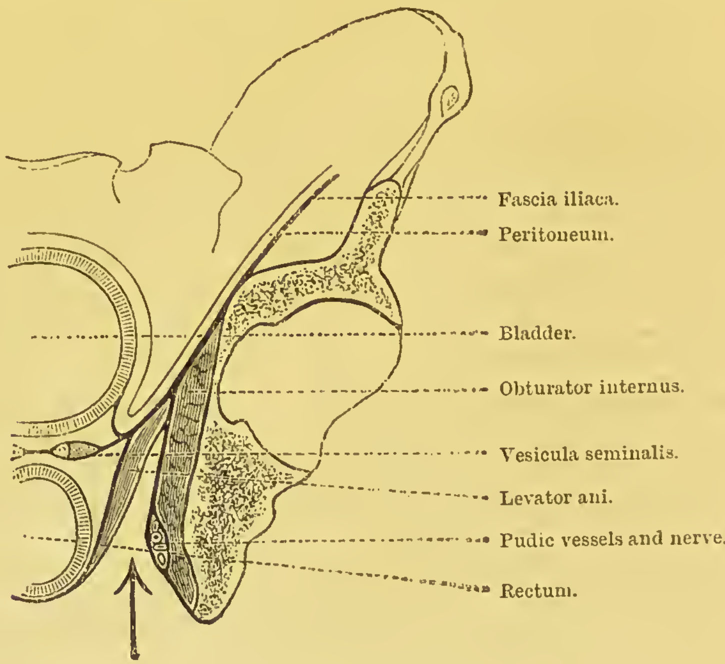


FIG. 2.

The arrow is directed upwards into the ischio-rectal fossa. The parietal pelvic fascia is seen upon the inner surface of the obturator internus. Observe also the anal fascia clothing the outer surface of the levator ani and the rectal fascia upon its inner surface.

the *inner* or *rectal wall* by the anal fascia. *In front* the space is limited by the base of the triangular ligament and by the transversus perinei muscle—whilst *behind* it is bounded by the posterior or lower margin of the gluteus maximus, the great sacro-sciatic ligament, and coccygeus muscle.

Contents.—The ischio-rectal fossa is completely filled up by a mass of fat which is prolonged upwards into it from the superficial fascia. The soft pliable nature of this fat readily allows of the distension of the rectum. Embedded in its midst are certain blood-vessels and nerves. Crossing the fossa from its outer to its inner wall are the *inferior hæmorrhoidal vessels and nerves*; entering the fossa at its posterior part is the *perineal branch* of the *fourth sacral nerve;* whilst in the anterior part of the space will be found the commencement of the *posterior superficial perineal nerve* (Fig. 3, p. 12).

Dissection.—Begin by exposing the posterior margin of the *gluteus maximus* muscle. Take a point a short distance to the outside of the tuber ischii and another in the middle line about an inch above the tip of the coccyx, and cut boldly down through the superficial fascia, in a line between these points, until the fleshy fibres become visible. Winding round the lower margin of the muscle so as to gain its superficial aspect, you will recognise a few small arteries and nerves. The arteries are derived from the *inferior hæmorrhoidal vessels*, or from the *sciatic artery*, whilst the nerves are offsets from the *small sciatic nerve*. Both are destined for the supply of the skin in the lower part of the gluteal region. Having secured these vessels and nerves, clean the lower margin of the gluteus maximus, and then proceed to dissect the ischio-rectal fossa. If the subject is obese, a considerable quantity of fat may be removed at once without endangering the inferior hæmorrhoidal vessels and nerves. Take the surface of the gluteus maximus and the margin of the external sphincter as guides, and transfix the fat with the knife in this plane. The adipose tissue superficial to this plane may be removed *en masse* with safety. The *hæmorrhoidal vessels and nerves* may be found by dissecting cautiously in the fat and carrying the knife in a transverse direction from the outer to the inner wall of the

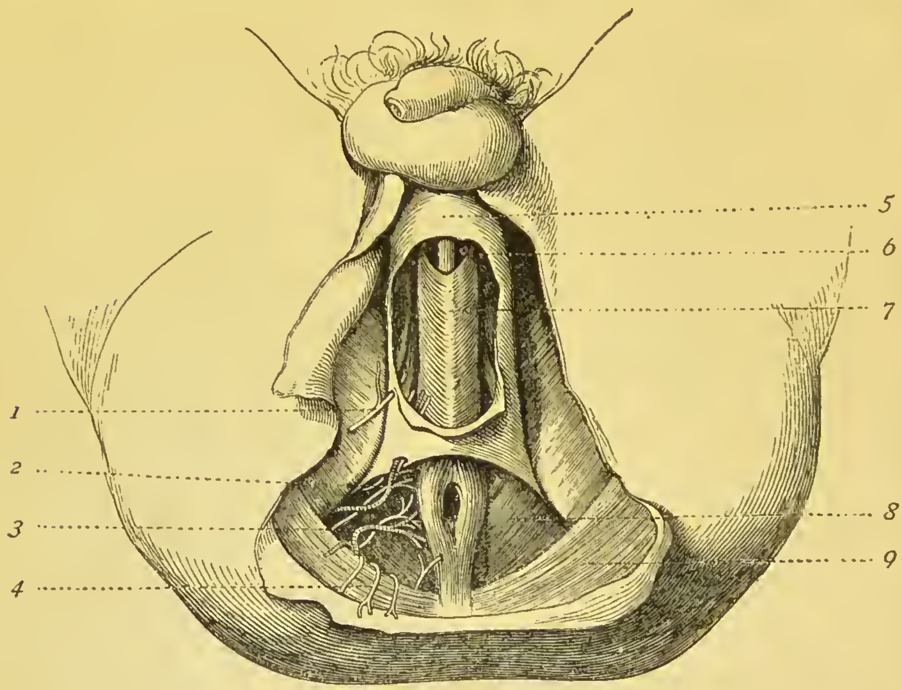


FIG. 3.

(1) Long pudendal nerve.
(2) Superficial perineal vessels and nerves.
(3) Hæmorrhoidal vessels and nerve.
(4) Cutaneous twigs from the sciatic nerve to gluteal region.
(5) Superficial fascia.
(6) Corpus spongiosum.
(7) Accelerator urinæ.
(8) Levator ani.
(9) Gluteus maximus.

space. The branch from the *fourth sacral nerve* appears by the side of the coccyx.

When the contents of the space are secured, continue to remove the fat from the fossa until its walls are fully displayed. On passing the finger upwards, you will notice that its passage into the pelvis is prevented by the junction of the anal fascia with the parietal or obturator layer of the pelvic fascia (Fig. 2, p. 10). Further, if the anal fascia be removed, its entrance into the pelvis is still resisted by the visceral layer of the pelvic fascia, which at this level passes inwards from the parietal pelvic fascia, and also by the levator ani muscle which lies on the lower surface of the visceral pelvic fascia and takes origin from the line of union between these two layers of fascia.

Internal Pudic Vessels and Nerve.—The dissector should now pass his finger upwards and downwards over the surface of the parietal or obturator layer of the pelvic fascia, which covers the obturator internus muscle and forms the outer wall of the ischio-rectal fossa. About an inch and a-half above the lower border of the ischial tuberosity he will feel very distinctly the pudic vessels and nerve as they pass forwards to gain the urethral triangle. In this position they are enclosed in a tube or sheath formed by the parietal pelvic fascia. The student must for the present be satisfied with this partial view of these structures. To expose them would necessitate the division of the parietal pelvic fascia, and this should be kept entire until the pelvic fascia can be studied as a whole.

Inferior Hæmorrhoidal Vessels and Nerve.—The *inferior* or *external hæmorrhoidal arteries* are branches of the internal pudic. They are usually two or three in number, and, piercing the parietal layer of the pelvic fascia, they pass inwards through the fat of the ischio-rectal fossa to supply the lower end of the rectum and the muscles in connection with it, as well as the skin around the anus. They anastomose with the corresponding arteries of the opposite side, whilst some minute twigs ascend to effect anastomoses with branches of the middle and superior hæmorrhoidal arteries. The *inferior hæmorrhoidal* veins, when they become varicose, give rise to hæmorrhoids.

The *inferior hæmorrhoidal nerve* accompanies the vessels. It may proceed directly from the sacral plexus, but more frequently it is a branch of the internal pudic nerve. Perforating the parietal layer of the pelvic fascia, it enters the ischio-rectal fossa, and then it breaks up into muscular, cutaneous, and communicating branches. The *muscular* twigs supply the external sphincter ; the *cutaneous* offsets are given to the skin which surrounds the anus, whilst the *communicating* filaments pass forward to join the long pudendal nerve and the superficial perineal nerves.

Perineal Branch of Fourth Sacral Nerve.—This small nerve enters the ischio-rectal fossa by piercing the coccygeus muscle at the side of the coccyx. It is distributed to the skin between the anus and coccyx, and to the external sphincter muscle.

Urethral Triangle.

The superficial fascia in this locality has already been studied. The following is a list of the structures which still require to be examined :—

(1.) The superficial perineal vessels and nerves.
(2.) The long pudendal nerve.
(3.) The root of the penis } The bulb and the crura.

(4.) The superficial perineal muscles.
- (*a*) Transversus perinei.
- (*b*) Accelerator urinæ.
- (*c*) Erector penis.

(5.) The triangular ligament.
(6.) The pudic vessels and nerve and their branches.
(7.) The compressor urethræ muscle.
(8.) Cowper's glands.
(9.) The membranous portion of the urethra.
(10.) The posterior layer of the triangular ligament (*i.e.*, the parietal pelvic fascia opposite the pubic arch).

Superficial Perineal Vessels and Nerves.—The superficial perineal vessels and nerves must now be followed out. There are two arteries and three nerves to be looked for :—

Arteries.
- (1.) Superficial perineal artery.
- (2.) Transverse perineal artery.

Nerves.
- (1.) Posterior or internal superficial perineal nerve.
- (2.) Anterior or external superficial perineal nerve.
- (3.) The long pudendal nerve or the nerve of Soemmerring.

The *superficial perineal artery*, a branch of the pudic, first pierces the parietal layer of the pelvic fascia, and then the base of the triangular ligament, so as to gain the interior of the perineal pouch of fascia. It now crosses the transversus perinei muscle, and is continued forward in the interval between the accelerator urinæ and erector penis to the scrotum, to the dartos muscle and integuments of which it is distributed in the form of numerous long, slender branches. Before it reaches the scrotum, it supplies twigs to the superficial perineal muscles. It is accompanied by the superficial perineal nerves.

The *transverse perineal artery* is a small vessel which usually springs from the pudic by a common root of origin with the preceding. It pierces the base of the triangular ligament, and, gaining the surface of the transversus perinei muscle, proceeds transversely inwards to the interval between the rectum and the bulb, where it ends by supplying the parts in this locality, and by anastomosing with the corresponding vessel of the opposite side.

The *posterior superficial perineal nerve*, a branch of the perineal division of the pudic nerve, has already been seen in the anterior part of the ischio-rectal fossa, where it effects a communication with the inferior hæmorrhoidal nerve. It leaves the fossa by piercing the base of the triangular ligament, and is continued forwards with the superficial perineal artery to the scrotum.

The *anterior superficial perineal nerve*, also derived from the perineal part of the pudic nerve, supplies a few twigs to the levator ani, and, piercing the base of the triangular ligament, is prolonged forward with the posterior nerve to the scrotum. In some instances this nerve passes under cover of the transversus perinei muscle.

The *long pudendal nerve* is derived from an altogether different source. It is a branch of the small sciatic nerve, and pierces the deep fascia of the thigh a short distance in front of the tuber ischii and about an inch and a-half to the outer side of the margin of the pubic arch. As it proceeds forwards it inclines inwards, and, piercing the attachment of the superficial fascia to the margin of the pubic arch, it accompanies the other vessels and nerves to the scrotum, the outer and front part of which it supplies. Instead of searching for this nerve at the point where it becomes superficial, and then following it towards its distribution, it is much easier to find it after it has entered the perineal pouch of fascia. Here it will be discovered lying in close relation to the two preceding nerves, but to their outer side. Trace it forwards and backwards. The long pudendal communicates with the inferior hæmorrhoidal nerve, and also with the posterior superficial perineal nerve.

Divide the superficial perineal vessels and nerves, and throw them aside.

Root of the Penis.—At this stage of the dissection the student should consider the position of the triangular ligament, and the relation which it bears to the root of the penis. The *triangular ligament* is a strong aponeurotic membrane which stretches across the pubic arch, and subdivides the urethral portion of the perineum into a superficial and a deep area. The *root of the penis* is placed altogether in front of it, in the superficial area of this region. With the handle of the knife clear away for a short distance the loose tissue which surrounds the body of the penis. The *body of the penis* is then seen to consist of three cylindrical masses placed in close apposition with each other. These are the two corpora cavernosa and the corpus spongiosum.

The *corpora cavernosa* constitute the chief bulk of the organ. They are placed side by side like the two barrels of a double-barrelled gun. They form the dorsum and sides of the penis, and are partially blended with each other along the middle line,—indeed the only surface indication of the double nature of this portion of the penis are two median longitudinal grooves which run one along its upper and the other along its lower aspect. The *corpus spongiosum* is slender in comparison with the corpora cavernosa, and is lodged in the groove which extends along the lower aspect of these bodies. To carry out our simile, then, the corpus spongiosum would correspond in position to the ramrod of the double-barrelled gun; and, on account of this, the body of the penis has a somewhat prismatic form. The corpus spongiosum is traversed throughout its whole extent by the urethra.

If these three constituents of the penis be traced backwards, the student will observe that opposite the lower part of the symphysis pubis they separate from each other and become attached to parts in the superficial area of the urethral triangle. The *corpora cavernosa* diverge widely from each other, and now they receive the name of the *crura* of the penis. Each crus is fixed firmly to the corresponding side of the pubic arch by an attachment which extends from the subpubic ligament backwards to the tuberosity of the ischium. Close to the point where it becomes continuous with the corresponding corpus cavernosum it shows a slight dilatation or bulging; from this to its posterior extremity it gradually tapers away. The *corpus spongiosum* is continued backwards in the middle line of the body to within a short distance of the anus, and it gradually expands so as to form a bulbous posterior extremity. The corpus spongiosum, as it lies in the interval between the diverging crura, is therefore termed the *bulb* of the penis. The bulb rests upon the superficial aspect of the triangular ligament, and it is firmly bound down to this by an aponeurotic investment, which is prolonged over it from the ligament.

The bulb and the two crura together constitute *the root of the penis*, and each is provided with a special muscle, which at present hides it from view. Clothing the bulb the student will recognise a bipenniform muscle called the *accelerator urinæ*, whilst moulded upon the surface of each crus is the *erector penis muscle*. These muscles should now be cleaned and their connections examined.

Superficial Perineal Muscles.—Under this heading are included not only the accelerator urinæ and erector penis muscles, but also the transversus perinei. The superficial perineal muscles have been seen to lie within the pouch formed by the superficial fascia and the triangular ligament. When the superficial fascia is removed each will be found to be invested by its own delicate aponeurotic layer.

The *transversus perinei muscle* is a narrow slip of muscular fibres which arises from the inner aspect of the ascending ramus of the ischium close to the tuberosity. It passes inwards and unites with the corresponding muscle of the opposite side in the central point of the perineum. From this blending of the two muscles in the middle line it has occurred to some anatomists to describe them as together forming one digastric muscle, and certainly this mode of description is calculated to give a better idea of their action. By their simultaneous contraction they steady the central point of the perineum, and give support to the anus during defæcation.

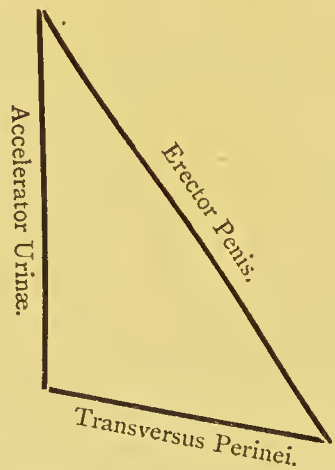
The central point of the perineum.—But what is this central point of the perineum? It is a tendinous point situated in the middle line of the body midway between the anus and the bulb. Towards this point, a number of the perineal muscles converge to obtain attachment. *On each side* it gives attachment to the transverse perineal muscles, *behind* to the sphincter ani, *in front* to the posterior fibres of the accelerator urinæ, whilst *from above* the anterior fibres of the levator ani descend to reach its *upper* aspect.

Accelerator urinæ, or *bulbo-cavernosus.*—This muscle is spread over the bulb and posterior part of the corpus spongiosum. It is composed of two symmetrical halves, and its fibres take origin from the central point of the perineum and from a fibrous median raphe which is prolonged forwards between the two halves of the muscle. The insertion differs according to the point at which the muscle is examined. The *posterior fibres* are simply attached to the superficial aspect of the anterior triangular ligament; the *middle fibres* sweep around the corpus spongiosum so as to invest it completely, and are inserted into a common aponeurosis upon the upper surface of this portion of the penis; lastly, the *anterior fibres* form two long narrow muscular bands which diverge from each other like the limbs of the letter V, and, passing forwards over the sides of the corpora cavernosa, are inserted into an aponeurosis on the dorsum of the penis. Thus the posterior fibres partially embrace the bulb; the middle fibres embrace the corpus spongiosum; whilst the anterior fibres embrace the body of the penis. The accelerator urinæ supports the urethra during micturition, and by its contraction it ejects the last drops of urine or semen from the passage.

Erector penis, or *ischio-cavernosus*.—This muscle lies upon the crus penis. It arises from the inner aspect of the tuber ischii, and is inserted by an aponeurotic expansion into the lower and outer surface of the anterior portion of the crus.

Perineal Nerve.—This is one of the two terminal branches of the pudic nerve. It supplies twigs to the skin, to the muscles of the perineum, and to the bulb of the penis. The *cutaneous* branches have already been followed out. They are the posterior and anterior superficial perineal nerves. *Muscular* twigs may be traced to each of the three superficial perineal muscles, whilst a few minute offsets pierce the triangular ligament to supply the compressor urethræ muscle. The *nerve to the bulb* is a small branch which breaks up into filaments for the supply of the corpus spongiosum.

Perineal Triangle.—If the superficial perineal muscles be now examined in regard to the relations which they hold to each other, the student will observe that they constitute the boundaries of a small triangular space upon each side of the middle line. The *base* of the triangle is formed by the transversus perinei; *externally* it is limited by the



erector penis, and *internally* by the accelerator urinæ. Let the student now place the point of his finger within this space and press upwards and backwards. He will perceive that it rests upon a strong resisting membrane. This is the triangular ligament, which therefore forms the floor of the space. It must now become the object of the dissector to obtain as good a view as possible of this ligament.

Triangular Ligament.*—To bring it into view, it is necessary in the first place to remove the super-

* To avoid confusion, it may be as well to mention that the terms "*deep perineal fascia*" and "*subpubic fascia*" are also applied to this structure.

ficial perineal muscles. When this is done the three divisions of the root of the penis are exposed to view, and their manner of attachment (which has already been described, p. 18) can be studied. Detach in the next place the crura penis from the sides of the pubic

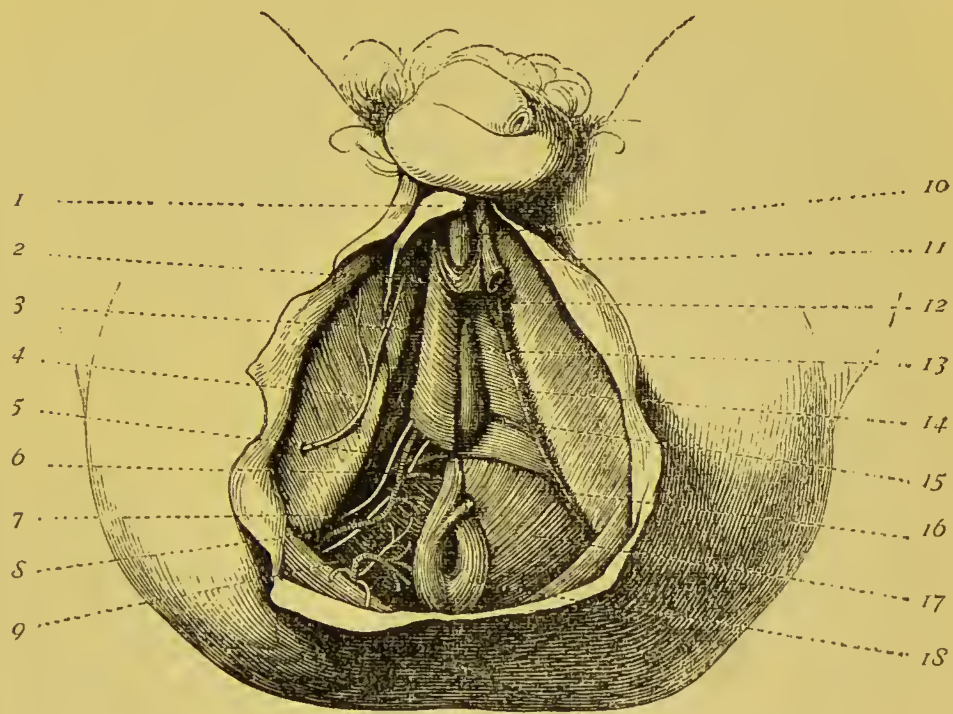


FIG. 4.

Superficial fascia removed; also one-half of the accelerator urinæ to show the bulb. On the left side the transversus perinei, the erector penis, and the crus penis have been taken away to display the triangular ligament.

(1) Superficial fascia.
(2) Accelerator urinæ.
(3) Erector penis.
(4) Long pudendal nerve.
(5) Transversus perinei.
(6) Anterior superficial perineal nerve.
(7) Posterior superficial perineal nerve.
(8) Superficial perineal artery.
(9) Hæmorrhoidal vessels and nerve.
(10) Corpus spongiosum.
(11) Crus penis (divided).
(12) Terminal branches of the pudic artery.
(13) Bulb.
(14) Triangular ligament.
(15) Artery to bulb.
(16) Internal pudic artery and nerve.
(17) Levator ani.
(18) Sphincter ani externus.

arch, and turn them aside. This must be effected with care, so as not to destroy the attachment of the ligament to the sides of the pubic arch, or to injure the pudic artery and dorsal nerve of the penis which pierce the ligament in its upper part.

The *triangular ligament* is now seen to be a strong aponeurotic membrane which stretches across the pubic arch. It is not, as is frequently stated, continuous with the parietal or obturator layer of the pelvic fascia. It must be regarded as lying in the same morphological plane as the bony and ligamentous wall of the pelvis, and as completing the pelvic wall in front in the same manner as the thyroid membrane fills up the gap formed by the thyroid foramen.

The *attachments* of this ligament are very precise. By its apex it is fixed to the subpubic ligament, and upon each side it is attached to the margins of the rami of the pubis and ischium. Its base is somewhat indefinite, and has already been seen to blend along the lower borders of the transversus perinei muscles with the deep surface of the superficial fascia. In addition to this attachment, however, a careful dissection in a good subject will show that the central part of the base projects backwards and downwards in the form of a short process or peak, which joins the central point of the perineum.

Surfaces.—In the erect posture of the body the superficial surface of the ligament looks downwards and forwards, whilst its deep surface looks upwards and backwards towards the cavity of the pelvis. In close contact with its anterior surface are the parts which constitute the root of the penis—viz., the bulb and the two crura and the muscles which are associated with them, also the transversus perinei muscles. The structures which are in relation to its deep surface will be studied when it is reflected.

Apertures.—The triangular ligament is not an unbroken continuous layer of fascia. It is pierced —(1.) by the urethra; (2.) by the pudic arteries; (3.) by the dorsal nerves of the penis; (4.) by the dorsal vein of the penis; (5.) and lastly, at its base, where it blends with the superficial fascia, by the superficial perineal vessels and nerves, as the dissector has already noticed. The *aperture for the urethra* is situated in the middle line, one inch below the symphysis pubis. It is not a clean cut hole with sharp edges. The margins of the opening are prolonged over the bulb of the penis so as to form for it an aponeurotic capsule. As soon as the urethra gains the superficial aspect of the ligament, it sinks into the bulb and is carried forwards through the entire length of the corpus spongiosum to its external opening on the glans penis. The *aperture for the dorsal vein of the penis* is also placed in the middle line, but at a higher level—viz., midway between the symphysis pubis and the opening for the urethra. The *dorsal nerve of the penis* and the internal pudic artery pierce the ligament at the same level as the vein, but external to it.

The term "*anterior layer*" of the triangular ligament is frequently applied to this membrane, which implies that there is a deeper or posterior layer to be studied in connection with it; and so there is. But whilst these layers are very intimately connected, they must be looked upon as being *distinct structures*. The anterior layer or triangular ligament we have seen to be in the same morphological plane as the bony wall of the pelvis and the thyroid membrane, and, in fact, to complete the pelvic wall in front. The *posterior layer* is simply the parietal layer of the pelvic fascia carried round to the front of the pelvis. Consequently the connections of this layer can be examined very much better in conjunction with the pelvic fascia. Suffice it for the present to say that inferiorly it is blended with the base of the triangular ligament, but that it recedes from the surface as it passes upwards, so that a space or interval is left between the two aponeurotic strata. Contained within this interval are the following structures:—

(1.) The membranous portion of the urethra.
(2.) The dorsal vein of the penis.
(3.) The compressor urethræ muscles.
(4.) Cowper's glands.
(5.) The pudic vessels and nerves and the artery to the bulb.

To expose these parts, the anterior layer of the triangular ligament must be raised upon one side of the body. It should be carefully preserved upon the opposite side, for in the subsequent dissection of the pelvis it is required as a landmark. On the side selected detach the ligament from the margin of the pubic arch, and, cautiously raising it from the subjacent structures, throw it inwards towards the bulb.

Membranous Portion of the Urethra.—The canal of the urethra is subdivided for descriptive purposes into three parts, according to the structures which are in relation to its walls as it passes from the bladder to its termination on the glans penis. These are—(1.) the prostatic portion; (2.) the membranous or muscular portion; and (3.) the spongy portion. Each of these subdivisions has a very definite relation to the triangular ligament; the prostatic part is placed behind this ligament; the membranous part is situated between the two layers of the ligament, whilst the spongy portion lies in front of the ligament.

Now that the anterior layer of the triangular ligament is removed upon one side, the student can readily feel with the point of the finger the staff as it lies within the membranous portion of the urethra. He should examine also its surroundings. It is the shortest subdivision of the urethra, and is distant one inch from the symphysis pubis. Throughout its entire extent it is enveloped by the fibres of the compressor urethræ, and on this account it is sometimes called the muscular part of the urethra. On each side, and at a lower level, are Cowper's glands, whilst midway between it and the symphysis pubis is the dorsal vein of the penis as it extends backwards between the two layers of the triangular ligament.

The Compressor or Constrictor Urethræ is a fan-shaped muscle. It has a narrow tendinous origin from the pubic arch close to the junction of the pubic and ischial rami. Expanding as it passes inwards towards the urethra, its fibres arrange themselves into two layers, which enclose between them the entire extent of the membranous portion of the urethra. The muscles of opposite sides meet therefore in the middle line, and the muscular fibres which compose the two layers are inserted into a median raphé, both upon the upper and lower aspects of the urethra. This muscle is supplied by one or two delicate twigs from the perineal division of the pudic nerve.*

Cowper's Glands.—As a general rule, these glands can readily be detected by raising the lower fibres of the compressor urethræ. They are small lobulated bodies resembling peas both in size and shape. They are placed one on each side of the middle line, immediately below the membranous part of the urethra, and are overlapped by the posterior part of the bulb—separated from it, however, by the triangular ligament. From each a minute duct proceeds, but this duct does not open into the membranous portion of the urethra. It passes forwards between the wall of the urethra and the substance of the bulb for the distance of one inch, and opens on the floor of the spongy part of the urethra.

Internal Pudic Artery.—The pudic artery is a

* The accounts given by different writers of the muscular fibres surrounding the membranous portion of the urethra are somewhat conflicting. No less than *three* distinct muscles are described by some authors—viz. (1.) the compressor urethræ; (2.) the levator urethræ, or Wilson's muscle; and (3.) the deep transverse muscle. The two latter are only occasionally present, and should simply be looked upon as specially developed portions of the constrictor. The *levator urethra* consists of two minute muscular slips which descend from the back of the symphysis pudis to enclose the membranous portion of the urethra. It is inserted into the central point of the perineum. The *transversus perinei profundus* is the name given to a few extra fibres added to the lower border of the constrictor by means of which it gains a distinct insertion into the central point of the perineum.

branch of the internal iliac. It is met with in three different regions of the body—viz. (1.) within the cavity of the pelvis; (2.) in the gluteal region, where it lies upon the spine of the ischium; and (3.) in the perineal space. It is consequently described as consisting of a *pelvic*, a *gluteal*, and a *perineal* part. The *perineal* or *third part* of the pudic artery enters the perineum by passing through the small sacro-sciatic foramen. At first it is placed deeply; but, as it is traced forwards, it is found to become more superficial, and, at the same time, to incline inwards, so that, at its termination, it lies close to the middle line of the body.

In the rectal triangle the pudic artery is contained within a sheath formed by the splitting of that part of the parietal pelvic fascia which forms the outer wall of the ischio-rectal fossa. It lies fully an inch and a-half above the level of the lower border of the ischial tuberosity, and is accompanied by two veins and the pudic nerve. The nerve occupies the lowest part of the sheath. Reaching the base of the urethral triangle, the pudic artery insinuates itself between the triangular ligament and the parietal pelvic fascia (*i.e.*, *posterior layer of the triangular ligament*), and gradually emerging from under cover of the bone, it proceeds forwards along the edge of the pubic arch to a point about half-an-inch below the symphysis, where it pierces the triangular ligament, and ends by dividing into two branches—viz. (1.) the artery to the corpus cavernosum, and (2.) the dorsal artery of the penis (Fig. 4, p. 23).

Branches of the Pudic Artery.—The pudic has already been seen to give off the *inferior hæmorrhoidal*, the *superficial perineal*, and the *transverse perineal arteries*, and to divide into its two terminal branches—*the dorsal artery of the penis* and the *artery to the corpus cavernosum*. Between the layers of the triangular ligament it gives origin to the *artery to the bulb*.

The *artery to the bulb* is a short wide vessel which springs from the pudic about a quarter of an inch above the level of the base of the triangular ligament. It passes transversely inwards between the two layers of this ligament, and, giving a small twig to Cowper's gland, it enters the substance of the bulb. It supplies the bulb and corpus spongiosum with blood; some branches also are sent to the glans penis.

The *artery to the corpus cavernosum* pierces the crus penis, and is carried forward in the substance of the corpus cavernosum, which it suplies with blood.

The *dorsal artery of the penis* runs forward in the interval between the crura penis, and, passing between the two layers of the suspensory ligament, gains the dorsum of the penis, where it will be afterwards traced.

The Pudic Nerve.—The pudic nerve is a branch of the sacral plexus. It has very much the same relations as the pudic artery. In the rectal triangle it is contained within the same sheath, in which it occupies the lowest level. After giving off the *inferior hæmorrhoidal nerve*, it divides into two terminal divisions—viz. (1.) the perineal nerve, and (2.) the dorsal nerve of the penis.

The *perineal nerve* has been seen to give off the following branches :—

Cutaneous. { (1.) The posterior superficial perineal.
(2.) The anterior superficial perineal.

Muscular. { (1.) The accelerator urinæ.
(2.) The erector penis.
(3.) The transversus perinei.
(4.) The compressor urethræ.

It also supplies one or two branches to the bulb and corpus spongiosum penis.

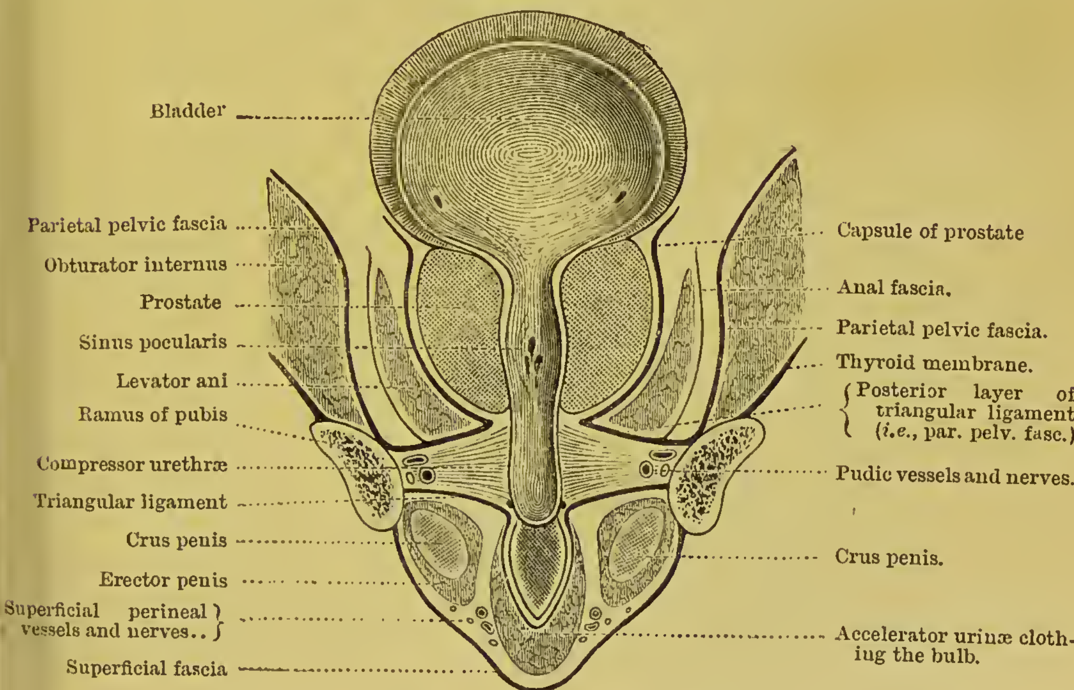


FIG. 5.

DIAGRAM. Vertical section through the pubic arch to show the two perineal compartments and their contents.

The *dorsal nerve of the penis* follows the pudic artery between the two layers of the triangular ligament, and, piercing the anterior layer of this ligament about half-an-inch below the symphysis pubis, accompanies the dorsal artery of the penis. At the root of the penis it supplies one or two twigs to the corpus cavernosum.

The dissection of the perineum is now completed, but whilst the body is in the lithotomy position and the various parts of the perineum exposed, the student should consider what structures still cover the perineal aspect of the prostate gland. Three layers would still require to be removed to bring the prostate into view—viz. (1.) the compressor urethræ muscle; (2.) the parietal pelvic fascia or the posterior layer of the triangular ligament; (3.) the anterior fibres of the levator ani muscle. Such being the case, you will observe that within the limits of the urethral triangle, and dissecting from the surface towards the prostate gland, we meet with an alternation of *muscular* and *fascial* strata, viz.:—

(1.) Superficial fascia.
(2.) *Superficial perineal muscles.*
(3.) Triangular ligament.
(4.) *Compressor urethræ muscle.*
(5.) Parietal pelvic fascia or posterior layer of triangular ligament.
(6.) *Levator ani muscle.*
(7.) Capsule of prostate and pubo-prostatic ligament.

Further, you should note that the fasciæ of the urethral triangle are so arranged that they form a superficial and a deep compartment, and that within one or other of these all the structures of this division of the perineum are contained (Fig. 5, p. 31).

The *superficial compartment* is bounded *in front* by the superficial fascia, *behind* by the triangular ligament, *laterally* by the attachment of these to the margins of the pubic arch, and *inferiorly* by the blending of the superficial fascia with the base of

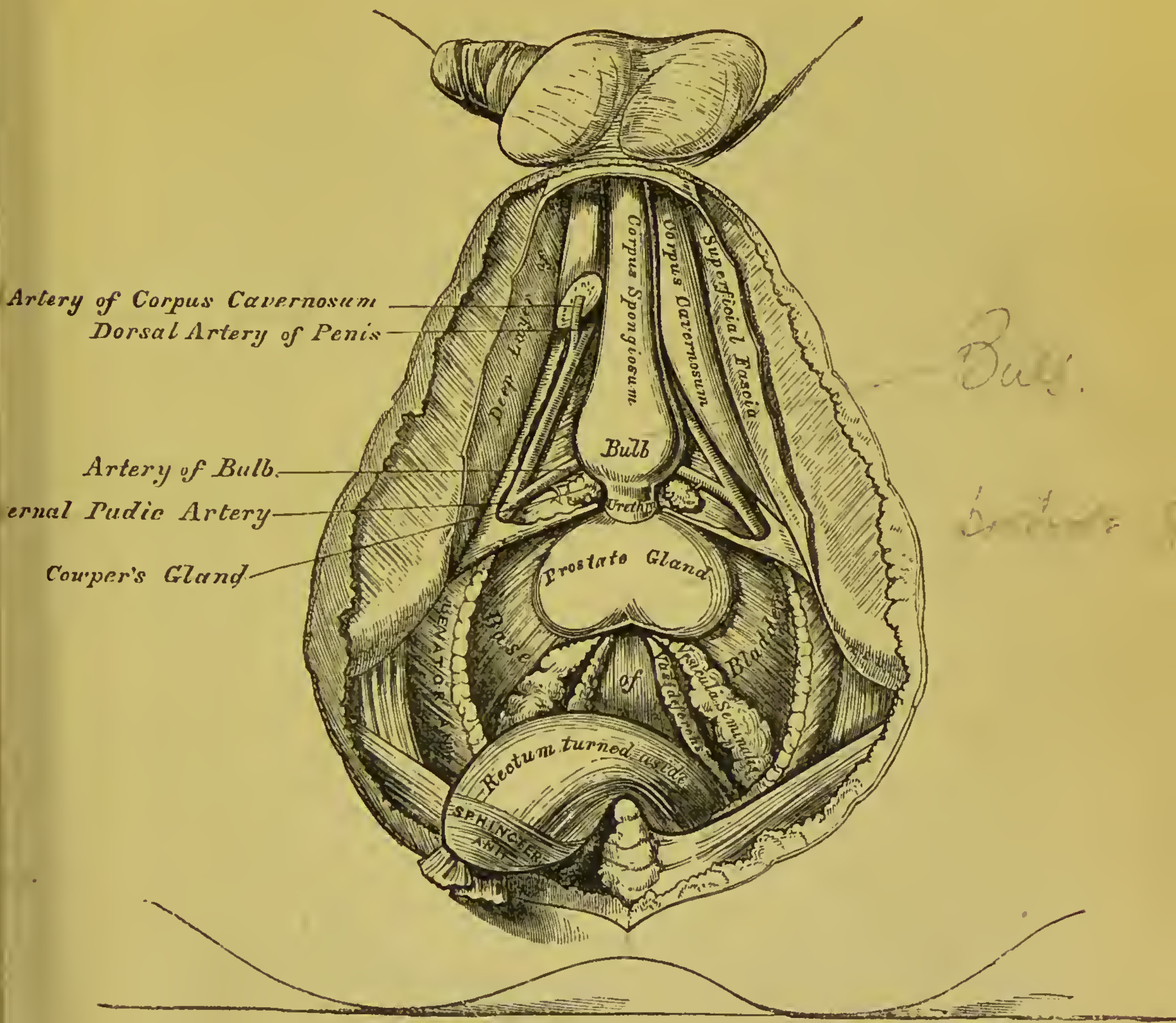


FIG. 6.

Deep dissection, in which the lower portion of the levatores ani muscles have been removed, and the external sphincter detached from the central point of the perineum, and the rectum turned back.—(From GRAY'S *Anatomy*.)

the triangular ligament. For the contents of this compartment see p. 7. (Fig, 5, p. 31.)

The *deep compartment* is the interval between the triangular ligament and the parietal pelvic fascia, and the structures which it contains are enumerated at p. 26. (Fig. 5, p. 31.)

Surgical Anatomy of Perineum.—In the rectal triangle the fatty tissue which fills up the ischio-rectal fossa is very liable, under certain circumstances, to inflammation. When pus forms, a knowledge of the structures which compose the walls of the fossa will show why *fistula in ano* so frequently results. The pus cannot pass upwards into the pelvis on account of the union of the visceral and parietal parts of the pelvic fascia; its passage outwards is resisted by the strong parietal layer of the pelvic fascia; whilst inferiorly the dense integuments of the hip prevent it from pointing towards the surface. The inner wall of the space, however, offers a weak resistance. Here the gut is guarded, it is true, by the rectal layer of the pelvic fascia, but in the lower part of the rectum this is very thin, and soon gives way before the continued pressure of the pus. The wall of the rectum then becomes thinned, and ultimately perforated, and the pus is voided through the anal orifice, giving rise to fistula. The lesson to learn from this is, that in every case of inflammation of the ischio-rectal fat an early incision should be made into the fossa so as to give free vent to the pus, and thus prevent its burrowing through the wall of the rectum.

In the *lateral operation of lithotomy* an accurate knowledge of the anatomy of the perineum is absolutely indispensable to the surgeon. He must know not only the structures which require to be divided, but also those which he must avoid, and how to avoid them. In the first incision, which begins at the middle line an inch and a-half in front of the anus, and extends backwards and outwards into the left ischio-rectal fossa midway between the anus and ischial tuberosity, the following parts are cut:—(1.) skin and superficial fascia; (2.) transversus perinei muscle and the transverse perineal artery; (3.) the lower or posterior edge of the triangular ligament; (4) the inferior hæmorrhoidal vessels. The forefinger of the left hand is next introduced into the middle of the wound and pushed upwards behind the triangular ligament until the groove of the staff, as it lies in the membranous part of the urethra, is felt. The point of the knife is now placed in the groove, and the blade lateralised. The knife is then carried steadily along the groove into the bladder. In this incision the structures divided are—(1.) the membranous and prostatic portions of the urethra ; (2.) the posterior layer of the triangular ligament ; (3.) the compressor urethræ muscle ; (4.) the anterior fibres of the levator ani muscle and the left lateral lobe of the prostate.

The dangers of this operation may be considered to be three in number—(1.) the artery of the bulb ; (2.) the pudic artery ; (3.) the rectum. Division of the artery to the bulb is an exceedingly awkward accident, and one which indeed might end fatally. The hæmorrhage resulting is very profuse, and exceedingly difficult to check on account of the short course of the vessel, its depth, and also its close connection with the layers of the triangular ligament which prevent it from retracting freely when cut. When this artery is in its normal position—*i.e.*, a quarter of an inch above the base of the triangular ligament—there should be little difficulty in avoiding it. In the first part of the operation it is merely the lower or posterior edge of the triangular ligament which is cut. Again, when the finger is introduced, so as to feel the staff in the membranous part of the urethra, the artery should lie in front of and superficial to it. When the artery to the bulb arises further back, as it sometimes does, it will, in all probability, be cut in this operation ; and there is no way of avoiding this, seeing that there are no means by which we can discover this abnormal origin beforehand.

The pudic artery runs no danger until it has given off the artery to the bulb, and has left the shelter of the pubic arch to lie between the layers of the triangular ligament. The risk of wounding this vessel is very slight, and it could only occur in the careless withdrawal of the knife. The superficial perineal branch of the pudic is frequently cut in the early stages of the operation, but under ordinary circumstances there is little difficulty in securing it. It has been stated, however, that if it should happen to be divided close to its origin, it might retract within the sheath of the pudic vessels, and the accident be in every respect as dangerous an occurrence as a wound of the main vessel itself.

Although the rectum lies in very close proximity to the membranous and prostatic parts of the urethra, it is very rarely injured. It is the invariable practice of the surgeon to empty the rectum by an enema prior to the operation.

A pad of tow, soaked in a mixture of spirit and carbolic acid, should be placed in the perineum, and the flaps of skin carefully stitched over it. On the *second day*, after the body has been brought into the Rooms, it is placed upon its face, and the dissectors of the abdomen stop work until the subject is turned, which is done *four days* later.

THE FEMALE PERINEUM.

The boundaries of the female perineum are identical with those in the male. The region, however, is wider

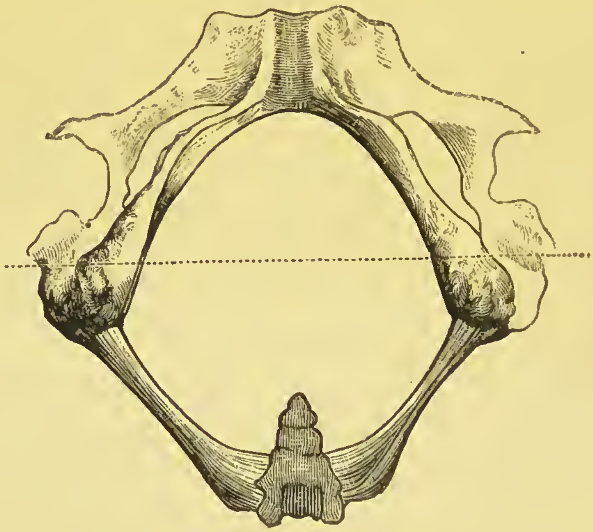


FIG. 7.
Outlet of Pelvis.

and of greater extent. For purposes of description, it is subdivided by an imaginary transverse line drawn in front of the anus and the tuberosities of the ischium into a posterior *rectal triangle* and an *anterior urethral triangle*.

External Anatomy.—The rectal triangle presents the same points for consideration as in the male. The external anatomy of the urethral triangle demands the careful study of the student, because here we find the external organs of generation. They are—

(1.) The mons Veneris.	(4.) The clitoris.
(2.) The labia majora.	(5.) The urethral opening.
(3.) The labia minora.	(6.) The vaginal orifice.

All these parts are included under the common term of **Vulva.**

The Mons Veneris is a marked cushion-like eminence situated in front of the pubes. This projection is due to a collection of adipose tissue under the integument. It is covered with short crispy hair.

The Labia Majora correspond to the scrotum in the male, cleft along the middle line. They are two rounded folds, which commence in front at the mons Veneris and extend downwards and backwards towards the anus. They diminish in thickness as they proceed backwards, and anteriorly they unite to constitute the *anterior commissure*, whilst posteriorly, about one inch in front of the anus, they join to form the *posterior commissure*. Externally, they are covered by skin studded with scattered hairs, whilst internally they are coated with smooth humid integument, the free surface of which is lubricated by an unctuous semi-solid secretion, derived from numerous follicular glands which open upon it. During parturition, the labia majora are unfolded and effaced, and thus give the vagina a greater capability of dilatation.

The labia majora enclose an elliptical fissure, which is termed the *uro-genital fissure or opening* on account of its containing the apertures of the urethra and vagina. Within this fissure, and a little way in front of the posterior commissure, a slightly marked transverse ridge or fold of mucous membrane will be observed passing between the two labia majora. This fold receives the name of the "*fourchette*" or "*frenulum pudendi*," whilst the term *fossa navicularis* is applied to the interval between it and the posterior commissure. The fourchette is usually ruptured in first labours.

It may be well for the student to bear in mind that the term "perineum" in the language of the accoucheur is used in a very restricted sense. It is given to the narrow interval which exists between the anus and the posterior commissure.

The Labia Minora or Nymphæ represent the male prepuce. They are two pendulous folds of mucous membrane which lie within the labia majora. To display them fully the labia majora must be pulled apart. They are placed one on each side of the vaginal orifice, and commence midway between the two commissures. As they proceed forwards they become more prominent, and at the same time converge so as to approximate to each other more closely. Reaching the clitoris, each terminates by splitting into two divisions or folds. The smaller and lower fold is attached to the under surface of the clitoris, and receives the name of "*frenulum clitoridis*." The upper fold arches over the clitoris like a hood, and unites with the corresponding fold of the opposite side to form the *preputium clitoridis*.

The Clitoris is the homologue of the penis, and, notwithstanding its diminutive proportions, it presents a close resemblance to the male organ both in appearance and structure. It is a minute reddish elongated projection placed below the anterior commissure. It is surmounted by a sensitive rounded tubercle called the glans. The manner in which its prepuce and frenum are formed has already been described. To obtain a proper view of the clitoris the student must lay hold of the glans with the forceps and draw it out from the prepuce.

The dissector should next take note of a smooth triangular interval which exists between the clitoris and the entrance to the vagina. The term *vestibule* is given to this area. It is bounded laterally by the nymphæ, and towards its lower part or base is seen the orifice of the urethra.

The Urethral Orifice lies close to the opening of the vagina about one inch below the clitoris. It is circular in form, and the mucous membrane around it is prominent, pouting and slightly puckered, so that when the tip of the finger is passed over the vestibular area the opening can readily be distinguished by touch.

The Vaginal Orifice is elliptical in form. In the virgin it is partially closed by the hymen—a semilunar fold of mucous membrane attached to the posterior aspect and sides of the entrance of the vagina and presenting a free concave margin towards the pubes. The form of the hymen, however, is very variable. Sometimes it is present in the shape of a circular septum pierced in the centre by a round opening; again it may be cribriform or fringed along its free margin. Lastly, it may present the two extremes—*i.e.*, it may be absent altogether, or constitute a complete septum across the opening of the vaginal canal. In the latter case most awkward results ensue from the retention of the menstrual fluid. When lacerated its position is marked by certain rounded elevations which have received the name of *carunculæ myrtiformes*.

Having mastered these facts regarding the external organs of generation, the dissector should practise the passing of the female catheter, and afterwards introduce a speculum into the vagina, so as to obtain a view of the os uteri.

The difficulty in passing the catheter arises from the fact that the operation must be conducted without any exposure of the person. Place the forefinger of the left hand in the orifice of the vagina with its palmar surface directed upwards towards the pubes. If the instrument be now passed along this finger and the point raised slightly when it reaches the entrance to the vagina, a little manipulation will cause it to enter the urethra.

When the speculum is introduced into the vagina the points to be noted in connection with the os uteri are:—(1.) the small size of the opening; (2.) the two rounded and thick lips which bound this aperture. In the virgin the opening is circular, but in women who have borne children it is somewhat transverse.

Note further that the anterior lip is the longer of the two, whilst the posterior lip is the thicker.

The rectum should now be moderately filled with tow, and the vulval and anal orifices stitched up.

Reflection of Skin.—*Incisions.*—(1.) A transverse incision should, in the first place, be carried from one ischial tuberosity to the other, in front of the anus; (2.) The uro-genital fissure and the orifice of the anus should next be closely encircled by incisions, and these joined by a cut along the middle line. (3.) Lastly, carry an incision forwards from the second or third piece of the coccyx along the middle line to the cut which surrounds the anus.

Four flaps are thus marked out; the two anterior may be thrown forwards and outwards, and the two posterior backwards and outwards.

Superficial Fascia.—The superficial fascia of the perineum is now laid bare. In the rectal triangle it agrees in every particular with the same portion of fascia in the male. In the anterior or urethral triangle, however, owing to the difference in the external organs of generation, there is a slight modification. It has the same attachments—viz., to the anterior lips of the pubic arch, and to the base of the triangular ligament, but it is not so membranaceous, and consequently does not form so distinct a layer. The two fascial pouches are also present in the female, and are sometimes spoken of as the *vulvo-scrotal sacs*. Their separation along the middle line is not due to the interposition of a median septum, as in the male, but to the presence of the uro-genital fissure.

Rectal Triangle.

Nothing need be added to what has already been written regarding this portion of the perineal space in the male. In both sexes the steps of the dissection and the parts found are precisely the same (*vide* p. 5).

Urethral Triangle.

Superficial Perineal Vessels and Nerves.—Under this heading we include *two arteries* and *three nerves*, viz. :—

Arteries. { The superficial perineal artery.
The transverse perineal artery.

Nerves. { The posterior superficial perineal nerve.
The anterior superficial perineal nerve.
The long pudendal nerve.

They have precisely the same disposition as the corresponding vessels and nerves in the male, with this exception, that they are somewhat smaller, and are distributed to the labium majus, instead of to the scrotum. For a detailed description of these structures, therefore, the student may refer to p. 15.

The Superficial Perineal Muscles.—The superficial perineal vessels and nerves should now be divided and thrown backwards, and the superficial perineal muscles cleaned. These are three in number :—

(1.) The transversus perinei muscle.
(2.) The erector clitoridis muscle.
(3.) The sphincter vaginæ muscle.

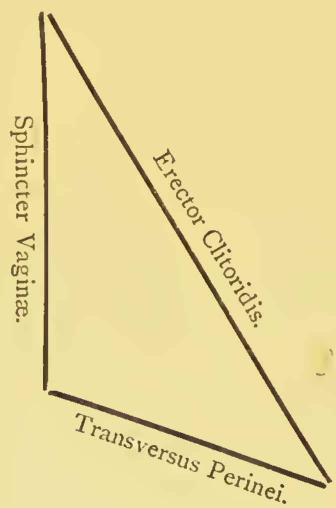
In cleaning these muscles the dissector should look for the small nervous twigs which are given to each by the perineal division of the internal pudic nerve.

The transversus perinei has the same disposition as in the male, but it is rare to find it so well marked in the female. In most subjects its fibres are pale, and it is very difficult to define. It is a slender fasciculus which takes origin from the inner surface of the ramus of the ischium close to the tuberosity, and passes obliquely forwards and inwards to its insertion into the central point of the perineum.

The erector clitoridis corresponds with the erector penis in the male. It is a small muscle which arises from the inner aspect of the ischial tuberosity, and is inserted into a tendinous expansion on the surface of the crus clitoridis.

The sphincter vaginæ is the representative of the accelerator urinæ of the male. It is a true sphincter muscle, and consists of two halves, which are placed one on each side of the vaginal orifice and vestibule, and are closely adapted to the surfaces of the two halves of the vaginal bulb. Posteriorly the fibres of opposite sides unite behind the vaginal opening, and are attached to the central point of the perineum, some of the fibres intermixing with those of the sphincter ani. Anteriorly the two portions of the muscle become narrower, and converging towards the middle line, are attached to the sides of the clitoris. In some cases a small fasciculus on each side may be observed to reach the dorsum of the clitoris, and there gain insertion into a tendinous expansion which lies superficial to the dorsal vein. This fasciculus is comparable with the anterior fibres of the accelerator urinæ in the male, which embrace the circumference of the body of the penis.

The Perineal Triangle.—The dissector should now observe that these three muscles form the sides of a small triangle, the floor of which is constituted by the anterior layer of the triangular ligament.



The sphincter vaginæ should now be carefully raised from the surface of the bulb, and the erector muscle from the surface of the crus clitoridis. The transversus perinei muscle may be removed at the same time.

Bulb of the Vagina.—The bulb of the vagina is now displayed. It consists of two oblong bodies, composed of erectile tissue, placed one on each side of the vestibule and entrance to the vagina. Somewhat narrow in front, they expand as they pass backwards, and each is invested by a fibrous capsule derived from the triangular ligament, upon the anterior surface of which they rest. Externally they present a rounded convex surface which is coated with the sphincter vaginæ muscle, whilst internally each erectile mass rests upon the deep surface of the mucous membrane of the vagina. In front of the urethra, between it and the clitoris, the two halves of the bulb are brought into direct communication with each other by a smaller venous plexus called the *pars intermedia*, which in turn is continuous with the erectile tissue of the glans clitoridis. To obtain a proper idea of these connections, it is necessary to study specimens which have been specially injected and prepared.

The arrangement of erectile tissue in the female, at first sight so unlike, corresponds in a remarkable degree to the bulb, corpus spongiosum, and glans penis in man. The apparent dissimilarity is due to the presence of the uro-genital fissure and orifice of the vagina. Let us suppose for a moment that these are obliterated; the two halves of the bulb would then be in contact with each other, and its entire surface would be covered by a muscular stratum, after the manner of the accelerator urinæ in the male. Further, the urethra would be surrounded by erectile tissue, and the *pars intermedia* would be seen to correspond in some extent to that portion of the corpus spongiosum which in man lies in front of the bulb, and becomes continuous with the glans.

The Clitoris.—The crura clitoridis have already been exposed by the removal of the erector muscles. To obtain a good view of the entire organ, strip the mucous membrane from the body of the clitoris, and clear away the loose tissue which surrounds it. In doing this, however, remember that on its dorsal aspect certain vessels and nerves run forwards to reach the glans, and that suspending it to the front of the pubes there is the suspensory ligament.

The *body of the clitoris* is composed of two cylindrical erectile bodies called the *corpora cavernosa*, which correspond with the structures that bear the same name in the male. Along the middle line they are united by their inner surfaces, and the erectile tissue of the one is separated from that of the other by an imperfect pectiniform septum. The body of the clitoris is about an inch and a-half long. Anteriorly it terminates in a small rounded tubercle, which bears the name of the *glans clitoridis*. The glans, however, is not structurally continuous with the corpora cavernosa. It is a little mass of erectile tissue continuous with the pars intermedia, and fitting into a slight concavity which is formed for its reception on the extremities of the corpora cavernosa. Posteriorly, opposite the lower part of the symphysis pubis, the corpora cavernosa separate, and diverging widely from each other, form the *crura clitoridis*. Each crus is attached by its deep surface to the rami of the pubis and ischium, and is covered by its own erector muscle.

The clitoris, then, consists of three parts:—(1.) *a glans* continuous with the pars intermedia; (2.) *a body* composed of two corpora cavernosa lying side by side and united along the middle line; and (3.) *two crura* attached to the sides of the pubic arch. We have seen that the pars intermedia corresponds with the corpus spongiosum in the male. This apparatus in the female, therefore, closely resembles the penis in man, the chief differences being the diminutive size of the clitoris, and the fact that the glans clitoridis is not perforated by the urethra.

The Triangular Ligament.—Detach the crura clitoridis from the sides of the pubic arch and throw them aside. This dissection requires care, because the pudic arteries, the dorsal nerves of the clitoris, and the small arteries which enter the crura are very apt to be injured. The pudic vessels and the dorsal nerve will be seen piercing the triangular ligament about half-an-inch below the symphysis pubis and a little way external to the middle line.

A good view is now obtained of the triangular ligament. Owing to the greater width of the pubic arch, it is a more extensive membrane than in the male. It does not possess the same strength, however, and is not so perfect, seeing that it is pierced by the vaginal canal. Its attachments are precisely the same—*i.e.*, (1.) by its apex to the subpubic ligament; (2.) by its base to the superficial fascia and the central point of the perineum; and (3.) by its sides to the margins of the pubic arch.

In the middle line, and from above downwards, it is pierced—(1.) about half-an-inch below the symphysis pubis by the dorsal vein of the clitoris; (2.) fully an inch below the symphysis pubis by the urethra; and (3.) immediately below the urethal opening by the wide vaginal canal. Its base is perforated, as we have seen, by the superficial perineal vessels and nerves, whilst the internal pudic artery and the dorsal nerve of the clitoris pierce it a little way external to the opening which transmits the dorsal vein of the clitoris.

The so-called *posterior layer of the triangular ligament* is really a part of the parietal layer of the pelvic fascia, as has already been explained, and it is altogether out of place to associate under one name two structures so distinct. Opposite the pubic arch, the parietal pelvic fascia (*i.e.*, posterior layer of triangular ligament) by its lower border fuses with the base of the triangular ligament. As it is traced upwards, however, it recedes from the triangular ligament, and consequently a space or interval is left between them. This interval is occupied by the following structures:—

(1.) The urethra.
(2.) A portion of the vagina.
(3.) The compressor urethræ muscle.
(4.) The dorsal vein of the clitoris.
(5.) The internal pudic vessels, and the artery to the bulb.
(6.) The dorsal nerve of the clitoris.
(7.) The glands of Bartholin.

To expose these structures, the triangular ligament must be reflected upon one side. Detach it from the margin of the pubic arch and throw it inwards.

Urethra.—The female urethra is a short wide canal, which extends from the neck of the bladder to its orifice on the vestibule. It measures about one and a-half inches in length, and has an oblique and slightly-curved course from above downwards and forwards. The concavity of the curve is directed forwards. So close is its relation to the anterior wall of the vagina, that it may almost be said to be embedded in it.

At the present stage of the dissection, the urethral canal is seen covered by the fibres of the compressor urethræ muscle.

The leading peculiarity of the female urethra is its great dilatability. Cases are on record in which vesical calculi weighing from two to four ounces have traversed it, and thus escaped from the bladder. It thus happens that in the extraction of foreign substances from the female bladder, it is rarely necessary to have recourse to the knife.

Compressor Urethræ.—This muscle differs somewhat from the corresponding muscle in the male. It has the same origin (viz., from the inner aspect of the pubic arch at the junction of the pubic and ischial rami), and it also divides into two bundles ; but these have not the same intimate relation to the urethra. The upper or anterior bundle spreads out upon the upper or anterior surface of the urethra, whilst the lower or posterior bundle spreads out upon the side and posterior aspect of the vagina. In the middle line they meet with the corresponding bundles of the opposite muscle, and thus the urethra and vagina are both included in a kind of deep sphincter.

The Vagina will be fully described in connection with the pelvic viscera.

Bartholin's Glands.—These glands are the representatives in the female of Cowper's glands in the male. They are two round or oblong bodies about the size of a horse-bean, placed one upon each side of the entrance to the vagina immediately behind the rounded end of the bulb, and under cover of the triangular ligament. A long duct proceeds from each gland, and opens on the inner aspect of the vaginal orifice external to the hymen.

Internal Pudic Vessels and Nerve.—The internal pudic vessels and nerve have a precisely similar disposition to the corresponding vessels and nerve in the male (p. 29). If anything, they are somewhat smaller.

The student must therefore look for the *artery to the bulb*, a branch of the internal pudic, which in this case is given to the bulb of the vagina, and the two terminal branches of the internal pudic artery—viz., the *dorsal artery of the clitoris*, and the *artery to the corpus cavernosum.*

The internal pudic nerve ends by dividing into the perineal nerve and the dorsal nerve of the clitoris.

The *perineal nerve* gives off—(1.) the anterior and posterior superficial perineal branches to the skin covering the labium majus; (2.) muscular twigs to all the perineal muscles, and (3.) a branch to the bulb of the vagina.

The *dorsal nerve of the clitoris* gives a twig to the corpus cavernosum, and runs forwards with the artery of the same name between the crura to reach the dorsum of the clitoris.

Dorsal Vessels and Nerves of the Clitoris.—On the dorsum of the clitoris a little dissection will display the *dorsal vein* occupying the groove in the middle line, with a *dorsal artery* and *nerve* lying upon each side of it.

The arteries and nerves should be traced forwards to their distribution in the glans.

The *dorsal vein* takes origin in the glans. As it proceeds backwards it receives certain superficial veins and also tributaries from the corpora cavernosa. At the root of the clitoris it dips downwards between the crura, and piercing the triangular ligament about half-an-inch below the subpubic ligament, is continued backwards into the pelvis to join the plexus of veins around the neck of the bladder.

ABDOMINAL WALL.

On the fifth day after the dissection of the perineum is completed, the body is placed upon its back, with blocks under the chest and pelvis, and the dissectors of the abdomen begin the dissection of the abdominal wall (Pl. III.)

External Anatomy.—It is well, however, before proceeding to the actual dissection of the part, that they should bestow some attention upon the general configuration and bony prominences of the region. If the subject is obese the abdomen presents a smooth, rounded, and protuberant appearance; if, on the other hand, it is spare, the abdominal wall is depressed, and the lower margin of the thorax above, and the pubes, crest of the ilium, and Poupart's ligament below, stand out in marked relief. In the middle line, the student will notice a linear depression extending downwards towards the symphysis. This corresponds with the linea alba or the interval between the two recti muscles. It is a most important line to the surgeon, because here the wall of the abdomen is very thin and devoid of blood-vessels, and, in consequence, it is chosen as the site for the incisions in the operations of ovariotomy, Cæsarian section, and supra-pubic lithotomy. In the same line the trocar is introduced into the abdomen in the operation of paracentesis abdominis or tapping.

In this linear depression, rather nearer the pubes than the ensiform cartilage, is the *umbilicus* or *navel.* This is a depressed and puckered cicatrix, the floor of which is raised in the form of a little button-like knob. It results from the closure of a foramen in the abdominal wall of the fœtus, through which passed the constituents of the umbilical cord—viz., the umbilical vein, the two umbilical arteries, and the urachus.

In powerful well-developed subjects the rectus muscle stands out on each side of the middle line, and its outer margin gives rise to a curved line, the concavity of which is directed inwards. This line corresponds to the *linea semilunaris*—*i.e.*, the line along which the aponeurotic tendon of the internal oblique muscle splits to enclose the rectus.

The student should now place his finger upon the upper part of the symphysis pubis and carry it outwards, over the pubic crest, to the pubic spine; from this he should follow the line of Poupart's ligament to the anterior superior spine of the ilium, and, having identified these parts, let him next endeavour to determine the position of the external abdominal ring. This is easily done in a male subject. Immediately external to the spine of the os pubis the spermatic cord can be felt as it passes over Poupart's ligament to reach the scrotum. Taking this as a guide, push the loose skin of the scrotum upwards before the finger. The tip of the finger enters the opening, the sharp margins of which can now be felt.

In females who have borne children the skin over the lower part of the abdomen is wrinkled and scarred.

A dissection of the abdominal wall will display the following parts :—

(1.) Superficial fascia.
(2.) Cutaneous vessels and nerves.
(3.) The external oblique muscle.
(4.) The internal oblique muscle.
(5.) The lower six intercostal nerves and accompanying vessels; the ilio-inguinal and ilio-hypogastric nerves.
(6.) The transversalis muscle.
(7.) The rectus and pyramidalis muscles and the sheath of the rectus.
(8.) The transversalis fascia.
(9.) The deep epigastric and deep circumflex iliac arteries.

(10.) The superior epigastric and musculo-phrenic arteries.
(11.) The spermatic cord.
(12.) The inguinal canal.
(13.) The extra-peritoneal fat.
(14.) The parietal peritoneum.

Reflection of Skin.—*Incisions*—(1.) Along the middle line of the body from the ensiform cartilage to the symphysis pubis. At the navel the knife should be carried round so as to surround it with a circular incision. (2.) From the ensiform cartilage transversely outwards around the chest, as far back as the knife can be carried. (3.) From the symphysis pubis outwards along the line of Poupart's ligament to the anterior superior spine of the ilium, and then backwards along the crest of the ilium (Pls. I. and III.)

The large flap thus mapped out should be carefully raised from the subjacent superficial fascia and turned outwards. If the abdominal wall is flaccid, the dissection may be facilitated by inflating the abdomen. Make an incision through the umbilicus large enough to admit the nozzle of the bellows, and, when the walls are quite tense, secure the opening with twine, which has previously been *sewed* round the lips of the incision.

The Superficial Fascia.—The superficial fascia which is now laid bare is seen to present the same appearance, and possess the same characters as in other localities. Above it is thin and weak, and is directly continuous with the corresponding fascia over the chest. Following it downwards, it will be noticed to become more strongly marked, and to acquire a greater density. Towards the lower part of the abdomen it is customary to describe it as being composed of two layers—a fatty superficial stratum and a deep membranaceous stratum; but we regard this as a useless complication. It is true that the fat is not equally distributed throughout its substance, that it is chiefly found in its superficial meshes, and that consequently its deep surface has a membranaceous appearance; but this is no reason why we we should look upon it as consisting of two separate strata.

There is one point, however, in which this fascia differs somewhat from the same fascia in other parts of the body. It is more elastic; and this elasticity is due to the presence of elastic fibres in its deeper membranaceous part. Over the lower part of the linea alba the elastic tissue is often seen collected in the form of a distinct band. A reference to comparative anatomy gives interest to this fact. In the human subject this elastic band is the rudimentary representative of a continuous and distinct layer of yellow elastic tissue (*the abdominal tunic*), which is present in the horse.

But what becomes of the superficial fascia if we follow it downwards from the front of the abdomen? On each side it is continued over Poupart's ligament and enters the region of the thigh, and opposite the pubes it is carried, over the penis and spermatic cords, to the scrotum and perineum, where it has already been examined. On the anterior aspect of the thigh it has a linear attachment by its deep surface to the fascia lata. This attachment can be readily demonstrated, but, seeing that the dissection required encroaches somewhat upon the region of the thigh, it must be done in conjunction with the dissector of the lower limb. Divide the fascia horizontally from the anterior superior spine of the ilium to the middle line of the body. Raising the lower cut edge of the fascia from the subjacent pearly tendon of the external oblique, insinuate the fingers between them. The hand can now be pushed downwards, behind the superficial fascia,* without meeting any resistance until we reach the neighbourhood of Poupart's ligament. Here a very decided obstacle is opposed to the further progress of the hand—viz., the attachment of the fascia by its deep surface to the fascia lata. A little manipulation will show that this attachment stretches almost horizontally across the front of the thigh; that internally it coincides with Poupart's ligament, but that externally it falls below the line of this ligament.

Towards the pubes the finger can be pushed downwards behind the superficial fascia and along the spermatic cord into the perineum. No barrier opposes the passage of the finger in this direction.

If the dissector now recall the fact that in the

* As the superficial fascia is thus raised from the aponeurosis of the external oblique, the hypogastric branch of the ilio-hypogastric nerve will be seen piercing the aponeurosis, a little way above the external abdominal ring, and then sinking into the deep surface of the superficial fascia.

urethral triangle of the perineum the superficial fascia is attached laterally to the margins of the pubic arch, and posteriorly to the base of the triangular ligament, whilst anteriorly towards the abdomen it is free, he will have little difficulty in understanding the course which urine takes when extravasated from a rupture of the urethra in front of the triangular ligament. The effused fluid is directed upwards over the scrotum and penis, and along the spermatic cords to the front of the abdomen. From the abdomen it cannot pass downwards to the front of the thighs, owing to the attachment of the superficial fascia to the fascia lata. Unless vent be given to it by early and free incisions, it will continue to ascend over the abdomen.

Cutaneous Nerves.—A dissection must now be made of the cutaneous nerves of the abdomen. These are arranged on the same plan as the cutaneous nerves of the chest. We have therefore to look for an *anterior* and a *lateral series.*

Anterior series.	(1.) Anterior cutaneous nerves. (2.) Hypogastric branch of the ilio-hypogastric nerve. (3.) The ilio-inguinal nerve.
Lateral series.	(1.) Lateral cutaneous nerves. (2.) Lateral or iliac branch of last dorsal nerve. (3.) Iliac branch of ilio-hypogastric nerve.

The anterior cutaneous nerves are the small terminal twigs of the lower four or five intercostal nerves.

They pierce the flattened tendon of the external oblique muscle at variable points, some close to the middle line, and others a little distance from it. Entering the superficial fascia, they run for a short distance outwards. To find these nerves the best plan to adopt is to divide the superficial fascia along the middle line and reflect it cautiously outwards. The small arteries which accompany the nerves serve as guides.

The hypogastric nerve is the terminal twig of the ilio-hypogastric, and it lies in series with the preceding. In the dissection of the superficial fascia it has been seen piercing the aponeurosis of the external oblique immediately above the external abdominal ring.

The ilio-inguinal nerve comes out through the external abdominal ring, and is distributed to the integument of the scrotum and the inner aspect of the thigh.

The lateral cutaneous nerves are branches of the five lower intercostal nerves. They become superficial between the digitations of the external oblique muscle, and then each divides into an anterior and posterior division. The *posterior divisions* are small, and are directed backwards over the latissimus dorsi. The *anterior divisions* run forward, and a careful dissector may trace them as far as the outer margin of the rectus.

The iliac branch of the last dorsal corresponds with the lateral cutaneous branches of the intercostal nerves.

It differs from the other members of the series in not dividing into an anterior and posterior branch, and in being destined for the supply of the integument over the gluteal region. It pierces the external oblique muscle in a line with the other lateral nerves, and is then directed downwards over the crest of the ilium. It crosses the iliac crest about two inches behind the anterior superior spine, at a point corresponding to the posterior border of the tensor fasciæ femoris.

The iliac branch of the ilio-hypogastric nerve is also distributed to the skin of the gluteal region. It pierces the external oblique immediately above the iliac crest, which it crosses a little behind its middle point, and posterior to the iliac branch of the last dorsal nerve.

Cutaneous Vessels.—Cutaneous arteries are found accompanying the cutaneous nerves. Those which are associated with the lateral cutaneous nerves are branches of the *aortic intercostal arteries*, whilst those in relation to the anterior cutaneous nerves are derived from the *deep* and *superior epigastric arteries.*

In addition to these, *three* named branches of the femoral artery ramify in the superficial fascia of the groin.

These are—

(1.) The superficial pudic.
(2.) The superficial epigastric.
(3.) The superficial circumflex iliac.

They take origin in the thigh a short distance below

Poupart's ligament, and, piercing the fascia lata, diverge from each other in the superficial fascia.

The superficial pudic is directed inwards over the spermatic cord, and gives branches to the skin of the scrotum and under surface of the penis.

The superficial circumflex iliac proceeds outwards and upwards along the line of Poupart's ligament, and ends in the skin in the neighbourhood of the anterior superior spine of the ilium.

The superficial epigastric takes a vertical course upwards, and, crossing Poupart's ligament, ramifies in the superficial fascia over the lower part of the abdomen. Its branches extend as high as the level of the umbilicus.

The small *veins* which accompany these arteries open into the internal saphenous vein.

The Muscles of the Abdominal Wall.—The abdominal wall is formed anteriorly and laterally by *five pairs of muscles*, and by the aponeuroses which constitute their tendons. *In front* are the two *recti muscles* and the two *pyramidales muscles.* The recti are placed parallel to the middle line, and extend in a vertical direction from the pubic bones to the lower margin of the thorax. *On each side* three fleshy and aponeurotic strata are met with as we dissect from the surface towards the abdominal cavity. These strata are—(1.) the external oblique muscle; (2.) the internal oblique muscle; (3.) the transversalis muscle. The direction taken by the muscular fibres which compose each of these layers is different. The external oblique corresponds in this respect with the external intercostal muscles; the fibres proceed obliquely downwards and forwards. Again, the internal oblique resembles the internal intercostal muscles in the direction of its fibres; they are directed upwards and forwards, and thus the fibres of the two oblique muscles cross each other like the limbs of the letter X. Lastly, the fibres composing the transversalis muscle pursue a horizontal or transverse course.

This difference of direction in the fibres which compose these three strata is a source of strength to the fleshy part of the abdominal wall, and offers an insurmountable barrier to the protrusion of any of the abdominal contents. The two oblique muscles and the transversalis are prolonged forward to the middle line in the form of aponeuroses. The union of these with the corresponding aponeuroses of the opposite side forms the *linea alba*—a strong ligamentous band which extends in the median line from the symphysis pubis to the ensiform cartilage.

Obliquus Externus.—Remove the superficial fascia from the front of the abdomen. This will expose the aponeurosis of the external oblique muscle. Towards the thorax this aponeurosis is very thin, and is liable to injury unless the dissection be performed with care. Proceed cautiously also at the lower part of the abdomen, above the inner end of Poupart's ligament. Here the aponeurosis is pierced in the male by the spermatic cord. The lips of the opening thus formed are prolonged downwards upon the cord in the form of a thin membrane called the *external spermatic fascia.* In defining this the blade of the knife must be discarded. Work entirely with the handle.

The *obliquus externus* arises by *eight* pointed processes or digitations from the outer surfaces and lower borders of the eight lower ribs (Fig. 8). Of these, the *upper five* interdigitate with the digitations of the serratus magnus, and the *lower three* with those of the latissimus dorsi. From this origin the fibres proceed downwards and forwards with varying degrees of obliquity. The *posterior fibres* have a nearly vertical direction, and are inserted into the anterior half of the outer lip of the crest of the ilium. The *superior fibres* are almost horizontal, and the *intermediate fibres* are directed obliquely downwards and forwards, and both end in a strong aponeurosis called the *aponeurosis of the external oblique.*

Superiorly the aponeurosis of the external oblique is very thin, and is carried forwards to be attached to the ensiform cartilage. It is from this part of it that the pectoralis major derives fibres of origin. *Inferiorly* it is attached to Poupart's ligament, which, indeed, is simply the thickened lower border of the aponeurosis folded back upon itself. *Between these attachments* it proceeds forwards over the rectus, and is inserted into the linea alba and into the front of the os pubis.

In connection with this aponeurosis note that it is broadest and strongest inferiorly, that it is narrowest about the level of the umbilicus, but that it widens somewhat towards the ribs. Superiorly it is so thin

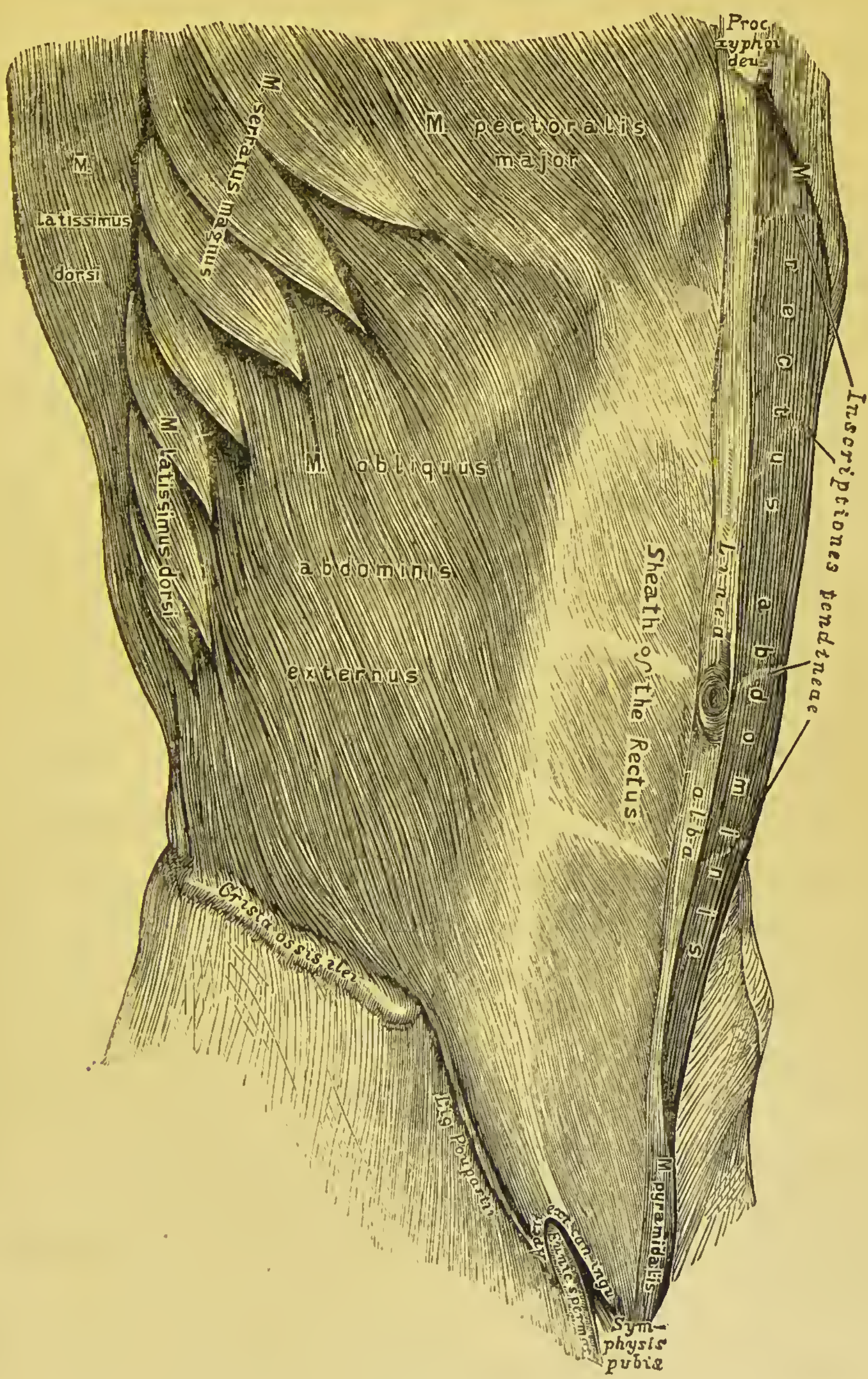


FIG. 8.
From HEITZMAN'S *Anatomy* (slightly modified).

that the fibres of the rectus muscle shine through it.

External Abdominal Ring (Fig. 8).—In the male, the aponeurosis of the external oblique is pierced immediately above the pubes by the spermatic cord; and in the female it is pierced, at the same point and in the same manner, by the round ligament of the uterus. The aperture, which is thus formed, receives the name of the external abdominal ring. At the present stage of the dissection, this opening is not visible, because its lips are carried downwards upon the spermatic cord or round ligament of the uterus in the form of a thin membranaceous fascia, which is called the *external spermatic* or the *intercolumnar fascia.* If the cord be raised and rendered tense, this covering will be observed to invest it completely, and to be somewhat funnel-shaped—wide above, but closing upon the cord as it is traced downwards.

With the point of the knife divide the external spermatic fascia round the cord, and then, with the handle, define the margins of the external abdominal ring. When this is done, the dissector will observe that the term "ring," as applied to this opening, is calculated to convey to the mind an erroneous impression. It is not circular, but *triangular in shape.* The *direction* of the opening is very oblique, the base of the triangle being formed by the crest of the pubes, whilst the apex is directed outwards and slightly upwards.

The external abdominal ring, therefore, is merely a small gap or interval left between that portion of the aponeurosis which is inserted into Poupart's ligament and that portion which is inserted into the front of the pubic bone. The margins of the aperture are termed *the pillars of the ring.* The *internal* or *superior pillar* is flat and broad, and is attached to the symphysis pubis. Some of its fibres cross the middle line, decussate with the corresponding fibres of the other side, and are inserted into the front of the opposite pubic bone. The *external* or *inferior pillar* is simply the inner end of Poupart's ligament. It is, therefore, thick and strong, and is fixed to the pubic spine. The spermatic cord, as it issues from the external abdominal ring, rests upon the external pillar.

The size of the external abdominal ring is very variable. In the male the average length may be said to be one inch or one inch and a-half, and the breadth about half-an-inch. In the female it is much smaller. In the female the round ligament of the uterus will be found to end in the superficial fascia of the groin.

On a close inspection of the lower part of the external abdominal aponeurosis, the student will observe a number of cross fibres. These are called the *intercolumnar fibres*, and in some cases they are very strongly marked. They begin at Poupart's ligament close to the iliac spine, and arch upwards and inwards above the external abdominal ring. The function of these fibres is very evident, and the term "*intercolumnar*" is derived from the part which they play. They bind together the two pillars of the ring, and prevent their further separation or divarication. There is a direct continuity between the intercolumnar fibres and the external spermatic fascia which clothes the cord, and consequently, as we have already seen, the term "intercolumnar" is frequently applied to the latter.

Reflection of the Obliquus Externus.—The external oblique muscle should now be reflected. Begin by detaching each digitation from the rib to which it is fixed. Between the last rib and the crest of the ilium the posterior border of the muscle will be found free; sometimes it is slightly overlapped by the latissimus dorsi, but in other cases a small portion of the internal oblique muscle can be observed in a triangular interval between them. These points can only be seen by tilting the body slightly over on its opposite side. Raise the posterior border of the muscle from the subjacent internal oblique, and divide the fleshy fibres which are inserted into the crest of the ilium close to the bone. Next divide the aponeurosis horizontally in a line leading from the anterior superior spine of the ilium to the outer border of the rectus. The entire muscular portion, and the greater part of the aponeurotic portion of the external oblique can now be thrown forward. On approaching the outer border of the rectus, the dissector must proceed with care, because a little beyond this the anterior lamella of the aponeurosis of the internal oblique fuses with the deep surface of the aponeurosis of the external oblique. Define the line of union, and notice that it does not extend beyond the lower margin of the thorax. Above this the rectus is simply covered by the aponeurosis of the external oblique; the outer margin of the muscle is bare, and the hand can be freely passed between it and the costal cartilages.

On the *left side* of the body, the parts below the horizontal line drawn from the anterior superior iliac spine to the outer border of the rectus, and along which the aponeurosis of the external oblique muscle has been divided, should be preserved intact for the special study of those parts which are related to inguinal hernia. On the *right side* of the body divide the lower part of the aponeurosis along the outer border of the rectus to the pubes. This incision should pass to the inner side of the internal pillar of the external abdominal ring, so that this opening may be preserved. The triangular flap of aponeurosis may now be thrown downwards and outwards. By this proceeding we can study more successfully Poupart's ligament, the entire extent of the internal oblique muscle, and the cremaster muscle.

Poupart's Ligament.* — Poupart's ligament is merely the thickened lower border of the aponeurosis of the external oblique folded backwards upon itself. It thus presents a rounded surface towards the thigh and a grooved surface towards the abdominal cavity. The manner in which it is attached by its outer and inner extremities deserves the close study of the dissector. *Externally* it is fixed to the anterior superior spine of the ilium; *internally* it has a double attachment — viz., (1.) to the pubic spine, which

* The term *superficial crural arch* is frequently applied to this ligament.

may be considered as its attachment proper; (2.) through the medium of Gimbernat's ligament to the ilio-pectineal line.

Poupart's ligament does not pursue a straight course between its iliac and pubic attachments. It describes a curve, the convexity of which is directed downwards and outwards towards the thigh. By its lower border it yields attachment to the fascia lata. When this is divided it at once loses its curved direction.

Gimbernat's ligament is a triangular process of aponeurotic fascia. Raise the spermatic cord, and place the finger behind the inner end of Poupart's ligament, and press downwards. The structure upon which the finger rests is the ligament in question, and the student should note that at this point it offers a barrier to the passage of the finger into the thigh. With the handle of the knife its shape and connections can be easily defined. *Its apex* is fixed to the pubic spine; by *one margin* it is attached to the inner end of Poupart's ligament; by *its other margin* it is inserted for the distance of an inch into the ilio-pectineal line. *Its base* is sharp, crescentic, and free, and is directed outwards towards the femoral sheath. Gimbernat's ligament occupies an oblique plane, its lower femoral surface looking downwards and slightly forwards and outwards, whilst its upper abdominal surface looks upwards and slightly backwards and inwards. It is of importance that the student should note the precise relation which this ligament bears to the spermatic cord. Taken in conjunction with Poupart's ligament and the aponeurosis of the external oblique, it forms a gutter or groove in which the cord lies.

In studying these points bear in mind that Poupart's ligament is merely the thickened lower border of the aponeurosis of the external oblique muscle, and that its attachments are therefore, strictly speaking, insertions of that muscle.

The Triangular Fascia* is a small triangular piece of fascia which springs from the attachment of Gimbernat's ligament to the inner end of the ilio-pectineal line. It passes upwards and inwards under cover of the internal pillar of the external abdominal ring, and is inserted into the linea alba. If the fibres which compose it are followed through the linea alba, they will be found to be continuous with the fibres of the aponeurosis of the external oblique muscle of the opposite side. It must, therefore, be considered as an additional insertion of this muscle. It is frequently very poorly developed, but usually it is so well defined that the handle of the knife can be insinuated behind it.

Obliquus Internus.—The internal oblique muscle should now be cleaned. Towards its lower part it will be seen to be pierced by certain nerves, and these must be preserved. Close to the iliac crest the *iliac branches* of the ilio-hypogastric and last dorsal nerves will be noticed emerging from midst its fleshy fibres,

* The term *triangular ligament* is frequently applied to this piece of fascia, but this is apt to lead to a confusion between it and the triangular ligament of the urethra.

whilst in front it is pierced by the *hypogastric branch* of the ilio-hypogastric and by the *ilio-inguinal nerve.* The former of these appears near the anterior superior iliac spine, and then proceeds forwards under cover of the external oblique aponeurosis, which it soon pierces. The ilio-inguinal nerve will be found perforating the internal oblique a little way in front of the hypogastric nerve and at a lower level. It becomes superficial by passing through the external abdominal ring.

The internal oblique muscle (Fig. 9) *arises*—(1.) from the abdominal grooved surface of Poupart's ligament in its outer half; (2.) from the middle lip of the anterior two-thirds of the iliac crest; (3.) from the lumbar aponeurosis. From this origin the muscular fibres radiate, but the general direction is from below upwards and forwards. *The posterior fibres* ascend, and are inserted into the lower borders of the cartilages of the lower four ribs. These fibres occupy the same plane as the internal intercostal muscles—indeed, they will be observed to be directly continuous with the fibres of the internal intercostal muscles of the two lower spaces. *The lower fibres*, or those springing from Poupart's ligament, arch downwards and inwards, and join with the lower fibres of the transversalis in a flat tendon, called the *conjoined tendon*, which is inserted into the crest of the pubes, and into the ilio-pectineal line, for fully half-an-inch of its extent. *The intermediate fibres* proceed upwards and forwards, and end in a strong aponeurosis, which extends from the lower margin of the chest to the pubis. By this aponeurosis they gain insertion into the lower borders of the seventh and eighth ribs and the ensiform cartilage, and into the linea alba throughout its entire length. The manner,

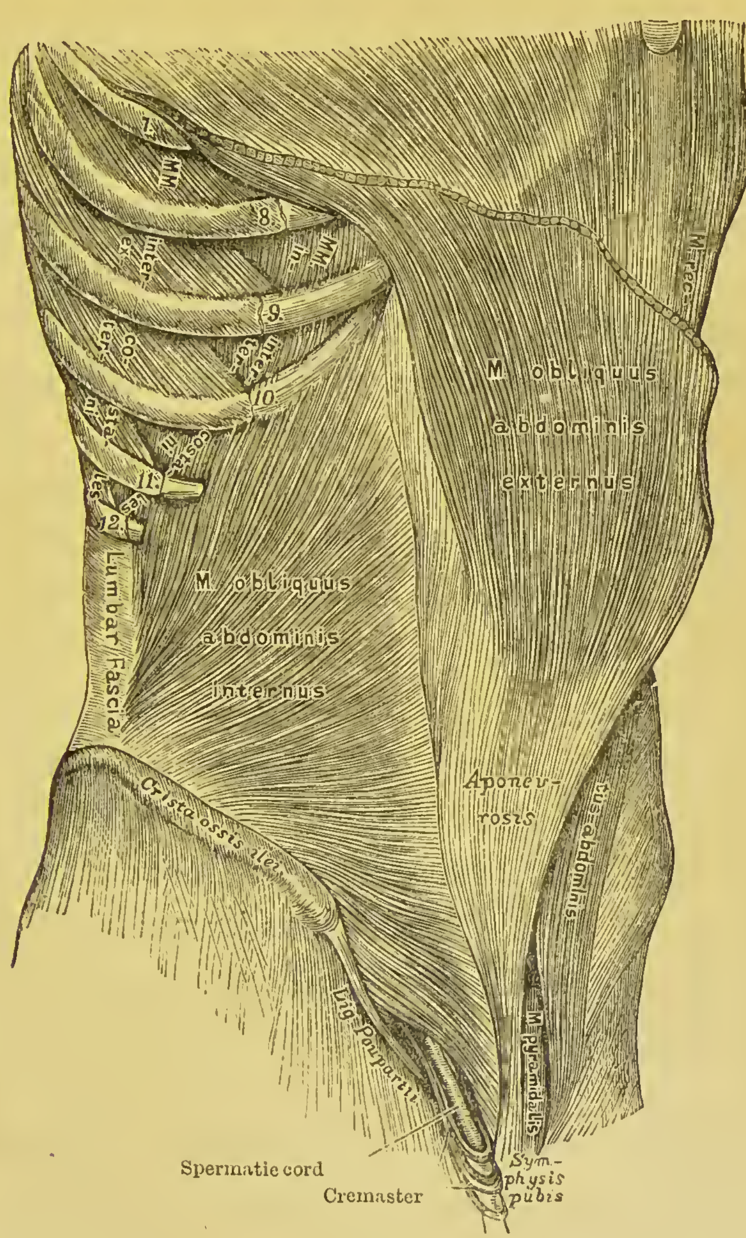


FIG. 9.

From HEITZMAN'S *Anatomy* (slightly modified).

however, in which the aponeurosis reaches the middle line requires special description.

At the outer margin of the rectus muscle the aponeurosis of the internal oblique splits into two layers —a superficial and a deep. The *superficial aponeurotic layer* passes in front of the rectus, and has already been seen to fuse with the aponeurosis of the external oblique muscle. The *deep layer* is carried inwards behind the rectus, and becomes incorporated with the subjacent aponeurosis of the transversalis muscle. But this arrangement does not hold good lower down than a point about midway between the umbilicus and the pubes. Below this point the tendon does not split, but passes entirely in front of the rectus, to join the aponeurosis of the external oblique.

It is very important to mark exactly the relation which the lower part of the muscle bears to the spermatic cord. At first the cord lies under cover of the fleshy fibres, but it soon emerges, clothed by the cremaster muscle, and as it is continued downwards and inwards to the external abdominal ring, it lies in front of the conjoined tendon. Especially note the position of the conjoined tendon in relation to the external abdominal ring. It lies immediately behind it, and gives strength to this otherwise weak point in the abdominal parietes.

Cremaster Muscle.—This muscle supports the testicle and spermatic cord, and is consequently peculiar to the male sex. It *arises* from the outer half of Poupart's ligament, but it also derives fibres from the lower border of the internal oblique, and rarely from the lower border of the transversalis muscle. The fleshy fibres descend upon the outer and anterior aspects of the cord in the form of loops, the concavities of which are directed upwards. The depth to which these loops descend varies. Some reach the tunica vaginalis of the testicle, and the scrotum should now be opened up on the right side, in order that they may be traced downwards to this point; the majority of the fibres, however, do not reach so far down, some going no further than the external abdominal ring. Upon the posterior aspect of the cord the loops are directed upwards, and some reaching the os pubis, obtain a tendinous insertion into its spine.

It will be noticed that the cremasteric fleshy loops do not form a complete investment for the cord and testicle. The intervals between the fasciculi are occupied by areolar tissue, and this combination of muscular and areolar tissue is sometimes termed the *cremasteric fascia.*

Reflection of Internal Oblique.—On the *right* side of the body the entire muscle may be reflected, but on the left side preserve the lower portion of it (which is still covered by the aponeurosis of the external oblique) *in situ.* Begin below by dividing the muscular fibres along the crest of the ilium. The depth to which the knife should be carried is indicated by the dense areolar tissue, which lies between it and the subjacent transversalis muscle. An ascending branch from the deep circumflex iliac artery will also serve as a guide. It emerges from the fibres of the transversalis close to the fore part of the iliac crest, and is then directed upwards upon its surface. Although this vessel has not attained the dignity of a name, it is a very constant branch. On the right side the fibres springing from Poupart's ligament should also be severed, but on the left side carry the knife horizontally inwards, from the anterior superior spine of the ilium to the outer margin of the rectus. Now turn your attention to the upper part of the muscle, and make an incision through it along the lower margin of the thorax, from the outer border of the rectus to the last rib. Lastly, carry the knife downwards, from the tip of the last rib to the crest of the ilium.

The muscle freed in this manner can be thrown forwards towards the outer border of the rectus. In doing this the dissector must proceed with caution, because he has reached the plane of the main trunks of the nerves of the abdominal wall and the arteries which accompany them. These pass forwards between the internal oblique and transversalis, and, in raising the former muscle, they are apt to adhere to its deep surface and be cut.

In all probability the student will experience considerable difficulty in separating the lower part of the internal oblique from the corresponding portion of the transversalis. At this level these two muscles are always closely connected, and in some cases they may be even found to be partially blended.

The *cremaster muscle* should also be reflected from the spermatic cord. This can best be done by making a longitudinal incision along it. Entering the deep surface of the cremaster is a small *branch of the deep epigastric artery* and the *genital branch of the genito-crural nerve.* These constitute its vascular and nervous supply, and must, if possible, be secured. Now clean the transversalis muscle, and dissect out the vessels and nerves which lie upon it.

Nerves of the Abdominal Wall.—Running forwards upon the transversalis muscle, the dissector will find the following nerves :—

(1.) The anterior portions of the lower six intercostal nerves. (2.) The last dorsal nerve.	The anterior primary divisions of the lower seven dorsal nerves.
(3.) The ilio-hypogastric nerve. (4.) The ilio-inguinal nerve.	From the anterior primary division of the first lumbar nerve.

The six lower intercostal nerves issue from the anterior ends of the six lower intercostal spaces, and then proceed forwards, between the internal oblique and transversalis muscles, to the outer border of the rectus. Here they disappear by piercing and passing within the sheath of this muscle. In a future dissection they will be observed sinking into the substance of the rectus, supplying it with twigs, and then turning forwards to pierce the sheath a second time. They end on the front of the abdomen as the *anterior cutaneous nerves.* Midway between the spine and the linea alba they give off the *lateral cutaneous* nerves. They likewise supply offsets to the transversalis and two oblique muscles. Minute arteries accompany these nerves.

The last dorsal nerve has the same relation in the abdominal wall as the preceding nerves. It gives off the same branches. Its *lateral cutaneous* branch, however, goes to the skin of the buttock.

The ilio-hypogastric and *ilio-inguinal* are the two lowest nerves of the series. They are directed forwards between the internal oblique and the transversalis close to the crest of the ilium.

The ilio-hypogastric is the higher of the two, and gives off an *iliac* or *lateral branch*, which pierces the two oblique muscles and then crosses the crest of the ilium to reach the skin of the gluteal region. The *hypogastric* portion of the nerve perforates the internal oblique a short distance in front of the anterior superior spine of the ilium, and then runs forwards towards the linea alba. It becomes superficial by piercing the aponeurosis of the external oblique immediately above the external abdominal ring.

The ilio-inguinal nerve gives off no lateral branch. It pierces the internal oblique, to which it gives branches, and it becomes superficial by passing through the external abdominal ring.

Transversalis Muscle.—This is the deepest of the three muscular strata which enter into the formation of the wall of the abdomen.* It has a threefold origin —viz., from the pelvis, from the vertebral column, and from the costal cartilages. By its *pelvic origin* it is attached to the outer third of Poupart's ligament and

* The transversalis lies on the same plane as the triangularis sterni muscle of the thoracic wall, and is thus considered by many to be the representative of that muscle in the abdominal wall.

to the anterior two thirds of the inner lip of the crest of the ilium; by its *costal origin* it arises from the inner surfaces of the costal cartilages of the lower six ribs by a series of slips or digitations which interdigitate with the slips of origin of the diaphragm; by its *vertebral origin* it is attached through the medium of the lumbar fascia to the spinous processes, transverse

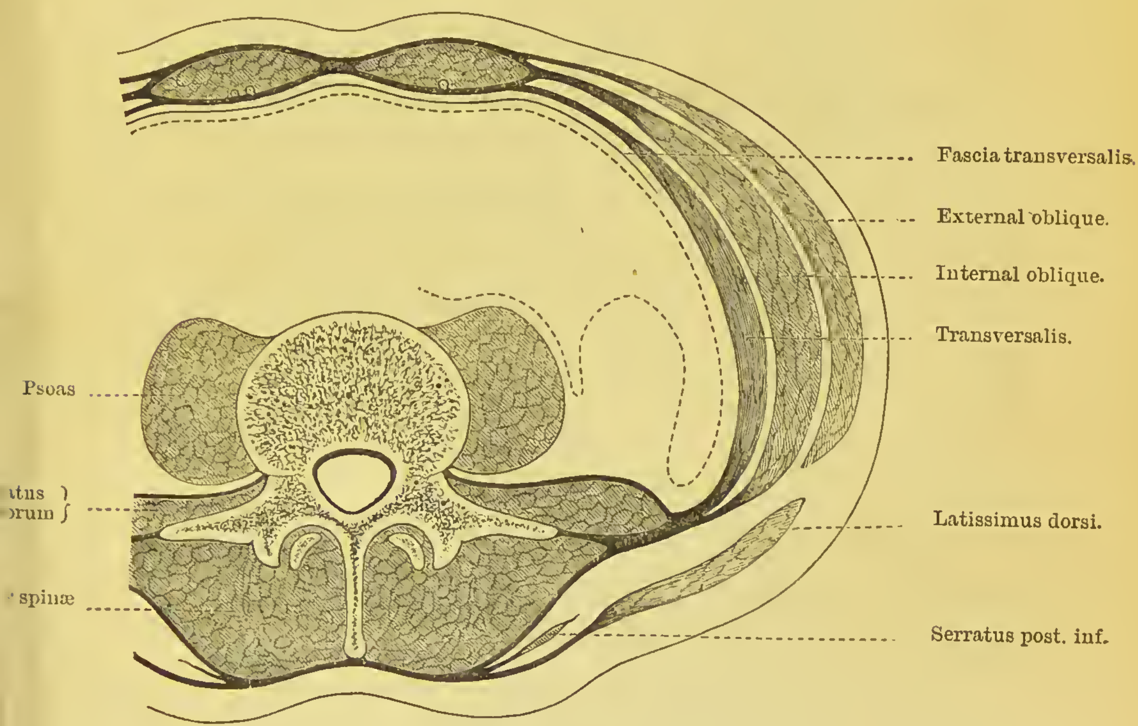


Fig. 10.
The dotted line represents the peritoneum.

processes, and bodies of the lumbar vertebræ. In point of fact, the lumbar fascia constitutes the posterior aponeurosis of this muscle. But the manner in which this fascia is attached to the vertebræ requires further explanation. As it approaches the spine it splits into three layers or lamellæ; of these the *posterior lamella* is attached to the tips of the spinous processes, the *anterior lamella* to the bodies of the vertebræ at the roots of the transverse processes, and the *intermediate lamella* to the tips and adjacent sides of the transverse processes. Two aponeurotic compartments are thus formed, the posterior of which is occupied by the erector spinæ, whilst in the anterior is placed the quadratus lumborum. These are points which cannot be demonstrated in this dissection, but a reference to Fig. 10 will help the student to understand the arrangement.

Anteriorly the fibres of the transversalis muscle end in a strong aponeurosis, which *is inserted* into the linea alba, the pubic crest, and the ilio-pectineal line. Towards this aponeurosis the fleshy fibres for the most part run in a transverse direction. The lower fibres, however, take a curved course downwards and inwards, so that the muscle presents a very distinctly arched lower margin.

The dissector has already seen that the lower portions of the aponeuroses of the internal oblique and the transversalis muscles blend to form the *conjoined tendon.* It is through the medium of this tendon that the transversalis gains its insertion into the pubic crest and into the ilio-pectineal line. Now examine the part which is played by the two factors of the conjoined tendon. You will notice that the aponeurosis of the transversalis constitutes the greater portion of it—indeed, whereas the internal oblique aponeurosis has an attachment to the ilio-pectineal line of little more than half-an-inch, the aponeurosis of the transversalis is fixed to fully an inch of this line.

Above the level of the conjoined tendon the aponeurosis of the transversalis is inserted into the

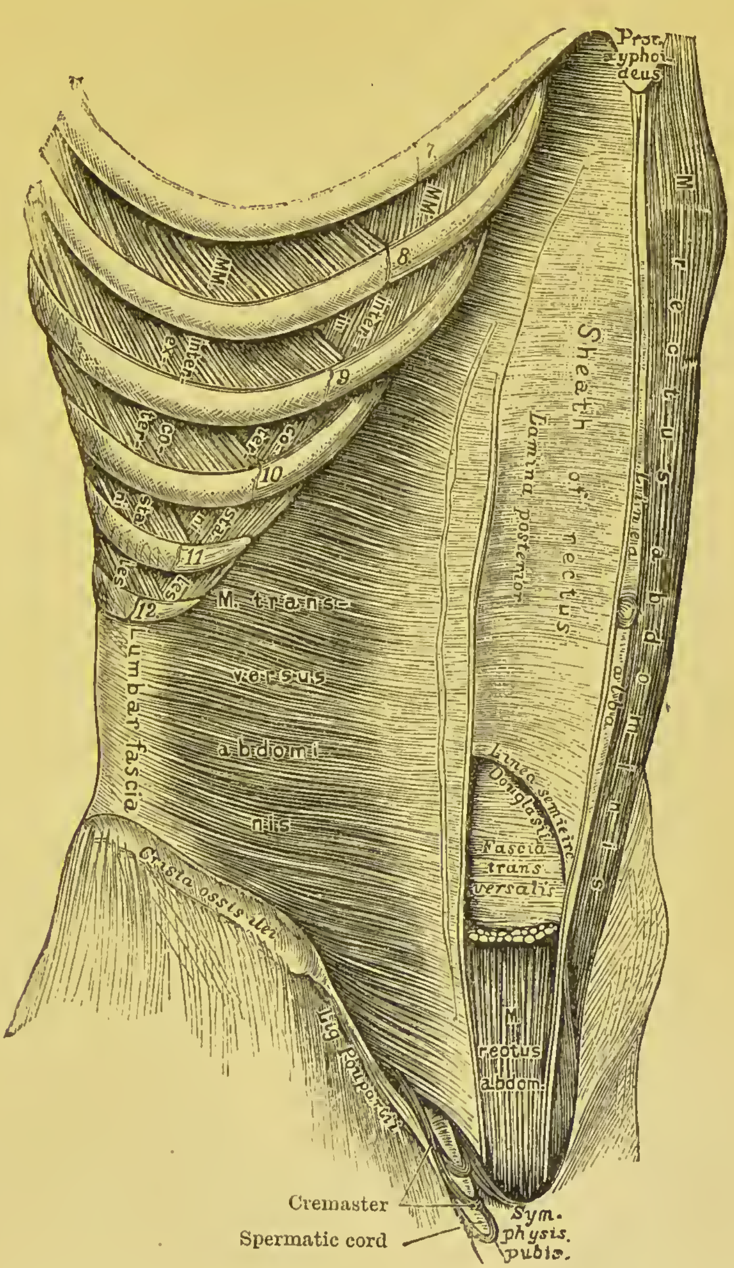


FIG. 11.

External oblique, internal oblique, anterior lamella of rectal sheath, and upper portion of rectus removed.—(From HEITZMAN'S *Anatomy*—slightly modified.)

linea alba, but in passing inwards to this insertion it presents two different relations to the rectus muscle. Down to a point midway between the umbilicus and pubes it passes *behind* the rectus, and blends with the posterior lamella of the aponeurosis of the internal oblique. Below this point it passes *in front* of the rectus, and blends with the aponeuroses of the internal oblique and external oblique.

Contents of the Sheath of the Rectus.—The sheath of the rectus should now be opened on both sides of the body by a vertical incision along the middle line of the muscle. The divided anterior lamella should then be carefully raised from the surface of the muscle and turned outwards and inwards. At the lineæ transversæ this can only be done with difficulty, so close is the connection between the sheath and the tendinous intersections of the muscle. Within the rectal sheath we find the following parts :—

(1.) The rectus muscle.
(2.) The pyramidalis muscle.
(3.) The terminal portions of the six lower intercostal nerves, and the last dorsal nerve.
(4.) The deep epigastric artery.
(5.) The superior epigastric artery.

In cleaning the rectus keep in mind the intercostal nerves and the last dorsal nerve. These will now be seen to enter the sheath and sink into the rectus. After supplying it with twigs, they come forward from its substance as the anterior cutaneous nerves of the abdomen.

Rectus Muscle.—This is a broad band of muscular fibres which stretches between the chest and the pubes, on each side of the linea alba. Inferiorly it *arises* by two heads; of these, the external and larger is attached to the pubic crest, whilst the internal and smaller is fixed to the ligaments in front of the symphysis pubis. Towards the chest the muscle widens and becomes thinner, and its *insertion* is effected by three large slips into the anterior aspect of the costal cartilages of the *fifth*, *sixth*, and *seventh* ribs.

The rectus muscle is broken up into portions by irregular tendinous intersections — the *inscriptiones tendineæ* or *lineæ transversæ*. These are usually three in number, and are placed, one at the level of the umbilicus, another opposite the ensiform cartilage, and a third midway between. A fourth intersection is sometimes found below the umbilicus. We have seen that these tendinous intersections are closely adherent to the sheath of the rectus in front. Raise the muscle, and you will observe that they have no attachment to the sheath behind.

Pyramidalis Muscle.—This is a small triangular muscle—not always present—which springs from the front of the pubes and the ligaments of the symphysis, and is inserted into the linea alba. It lies upon the lower part of the rectus, and is supposed to act as a tensor of the linea alba.

Sheath of the Rectus.—The dissector is now in a position to study the manner in which the rectal sheath is formed. An examination of the relations which the aponeuroses of the three flat muscles of the abdomen bear to the rectus, will show that the sheath is incomplete in so far as the rectus is concerned—it is deficient *posteriorly*, both above and below.

From the lower margin of the thorax to a point midway between the umbilicus and pubes, it encloses the rectus upon all sides. Here the *anterior wall or lamella* is formed by the aponeurosis of the external

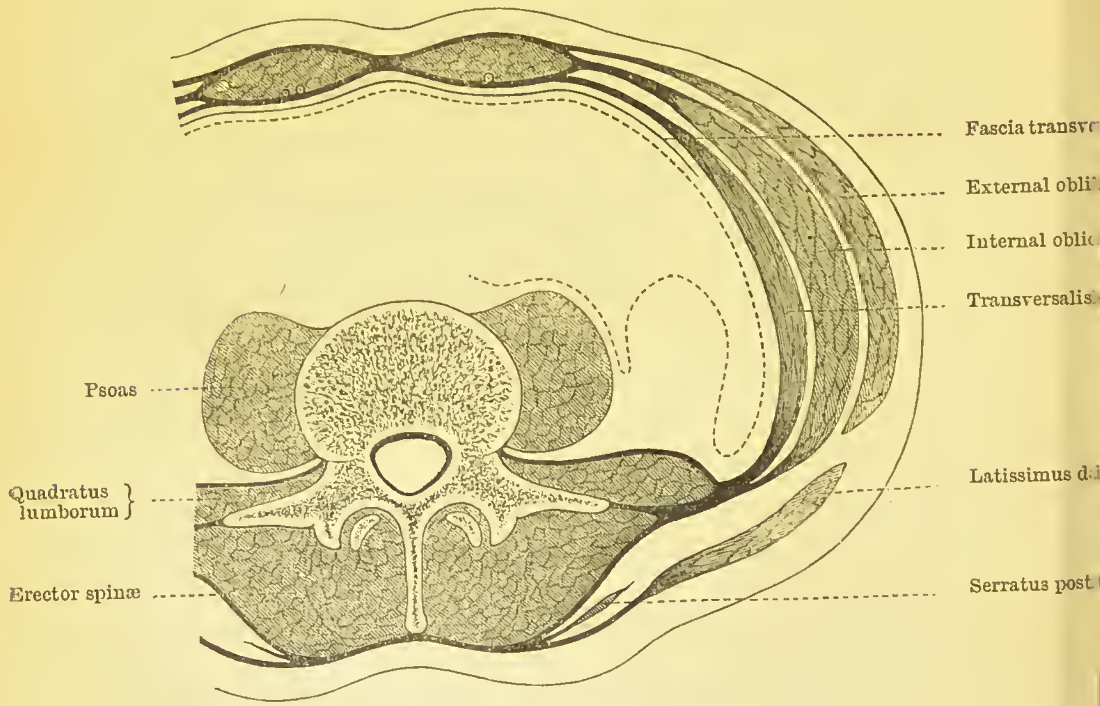


FIG. 12.
The dotted line represents the peritoneum.

oblique fused with the anterior layer of the aponeurosis of the internal oblique, whilst the *posterior wall or lamella* is formed by the fusion of the posterior layer of the aponeurosis of the internal oblique with the aponeurosis of the transversalis.

Superiorly, the rectus muscle rests directly upon the costal cartilages, and the sheath is merely represented by the aponeurosis of the external oblique, which covers the muscle anteriorly. *Inferiorly*, the posterior wall of the sheath is also absent, and the rectus rests on

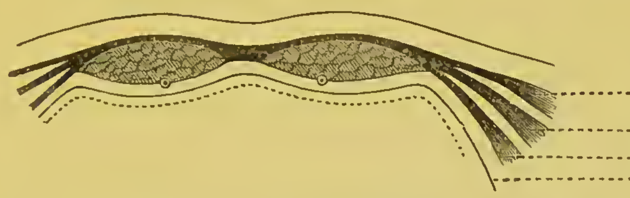


FIG. 13.

the transversalis fascia. Here, however, the anterior wall is formed by a blending of all three aponeuroses.

The lower free margin of the posterior lamella of the sheath can be easily defined by raising the rectus and working with the handle of the knife. It usually presents a sharp lunated edge, the concavity of which is directed downwards to the pubes. It is called the *semilunar fold of Douglas*. The deep epigastric artery will be observed to enter the sheath by passing upwards in front of this free border.

Linea Alba.—The linea alba can now be studied to the best advantage. It is a dense fibrous cord or band which extends perpendicularly between the ensiform cartilage and the symphysis pubis. It is very generally regarded as the continuation downwards of the sternum. It is formed by the union and decussation of the fibres composing the aponeuroses of the two oblique and the transversales muscles of opposite sides. Above the umbilicus it is somewhat broader than in its lower part. A close examination will show that it is pierced by several small round openings for the transmission of blood-vessels, and from some of these the dissector may even observe minute fatty masses protruding. A little below its middle is the umbilicus, but the foramen, of which this is the remains, is now completely closed; indeed, in the adult the linea alba is stronger at this point than elsewhere.

Fascia Transversalis.—This is a thin layer of fascia which is spread out upon the deep surface of the transversalis muscle. The fascia of one side is directly continuous with the fascia of the opposite side, and it forms a part of an extensive fascial stratum which lines the entire abdominal wall, and is placed between the abdominal muscles and their aponeuroses on the one hand, and the extra-peritoneal fatty tissue on the other.

Traced upwards, the fascia transversalis becomes thin and cellular, and at the margin of the thorax it is directly continuous with the fascia which lines the lower surface of the diaphragm. Towards the inguinal region it plays a most important part as a constituent of the abdominal wall. Here, then, it must be studied with great care.

In the present state of the dissection (on the right side of the body), a gap or interval is seen to exist between the lower arched border of the transversalis muscle and Poupart's ligament. The membrane which fills up this interval is the *transversalis fascia*. At no part of the abdominal wall is the fascia stronger than here, and this accession of strength is obviously for the purpose of compensating for the deficiency in the internal oblique and transversalis muscles, which, at this point, do not descend so low as Poupart's ligament. In this interval the transversalis fascia has a most important relation to the spermatic cord. Here the fascia is pierced by the cord, but as yet no opening is visible. Take hold of the cord and draw it downwards and inwards. The margins of the aperture through which it passes will be observed to be prolonged downwards upon the cord in a funnel-shaped manner, so as to invest it upon all sides with a tube of fascia. This investment, which is thus seen to come directly from the fascia transversalis, is called the *infundibuliform* or *internal spermatic fascia*.

It must now become the object of the student to demonstrate the more important attachments of this fascia. For this purpose divide the fibres of the transversalis muscle close to Poupart's ligament and the crest of the ilium, and raising the muscle from the subjacent fascia, throw it upwards. It is not necessary to reflect the entire muscle. When the fascia is cleaned with the handle of the scalpel, it will be seen to be attached *laterally* to the inner lip of the iliac crest. Along the line of this attachment, which is by no means firm, it becomes continuous with the *fascia iliaca*—that portion of the same fascial stratum which covers the iliacus and psoas muscles in the iliac fossa. Close to the crest of the ilium the fascia transversalis is pierced first by the ascending branch and then by the terminal branches of the deep circumflex iliac artery. *In front*, in the inguinal region, its connections are more complicated, and must be studied at three different points—(1.) between the anterior superior iliac spine and the femoral artery, where it will be seen to be attached to Poupart's ligament; along this line also it becomes continuous with the fascia iliaca; (2.) opposite the femoral vessels, where it is carried downwards into the thigh behind Poupart's ligament, to form the anterior part of the femoral or crural sheath; (3.) internal to the femoral vessels, where it is attached to the ilio-pectineal line and the pubic bone, behind the conjoined tendon, with which it is partially blended.

Internal Abdominal Ring.—We have seen that the transversalis fascia is pierced by the spermatic cord. The opening through which it passes is called the *internal abdominal ring*. This opening can only be defined from the front by an artificial dissection —viz., by dividing the infundibuliform fascia around the cord, and pushing it upwards with the handle of the knife. The ring thus defined will be observed to lie about half-an-inch above Poupart's ligament, at a point midway between the symphysis pubis and the anterior superior spine of the ilium. Through the opening the dissector can see the extra-peritoneal fat upon which the transversalis fascia rests, and immediately internal to the opening he will notice the deep epigastric artery, pursuing its oblique course upwards and inwards, and shining through the fascia. If the handle of the knife be now introduced into the ring and carried outwards between the fascia and extra-peritoneal fat, the attachments of the fascia to

Poupart's ligament and to the iliac crest can be very clearly shown.

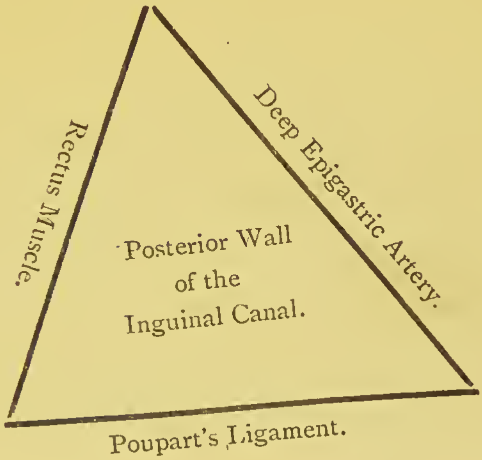
Inguinal Canal.—The dissector has observed that the spermatic cord in the male and the round ligament in the female pierces the abdominal wall above Poupart's ligament. The passage which is formed for its transmission receives the name of the *inguinal canal.* Now, as this canal is a source of weakness to the abdominal wall, and as it is in connection with it that inguinal hernia occurs, the student will understand how necessary it is that he should examine it carefully from all points of view.

The inguinal canal is a narrow groove or channel of about two inches in length. It begins at the internal abdominal ring, which may be spoken of as its inlet, and ends at the external abdominal ring, which constitutes its outlet, and, consequently, it is very oblique, having a direction almost directly inwards, with a slight inclination downwards and forwards. So much for its length and direction; we have still to make out in connection with it (1.) a floor; (2.) an anterior wall; and (3.) a posterior wall.

The floor is formed in the first part of the canal by the upper grooved surface of Poupart's ligament. Towards the outlet, however, the floor becomes broader and more definite; here it is formed not only by Poupart's ligament, but also by Gimbernat's ligament. At this point, as the student has already observed, the cord rests directly upon the abdominal surface of the latter ligament. The parts which enter into the formation of the *anterior wall* are—(1.) the aponeurosis of the external oblique throughout the entire extent of the canal; and (2.) the lower border of the internal oblique in the first part of the canal. These facts can be readily verified by restoring these structures to their original positions. The *posterior wall* next demands the attention of the student. The parts which compose it are still *in situ*. Naming them in order, from the inlet to the outlet, they are—(1.) the fascia transversalis; (2.) the conjoined tendon; and (3.) the triangular fascia, when it is strongly developed.

But it may be asked, Does the transversalis muscle take no part in the formation of the inguinal canal? The student can readily satisfy himself as to this point. He will notice that the arched lower border of this muscle does not descend so low as that of the internal oblique, that, in fact, it stops short at the internal abdominal ring. It follows from this, then, that if *a roof* were described in connection with the canal it might be said to be formed by the approximation of the anterior and posterior walls above the cord, and by the intervention between these walls of the lower borders of the transversalis and internal oblique.

There is still another point to be noted—viz., the relation which the deep epigastric artery bears to the posterior wall of the canal. This vessel can be felt (and, indeed, in most cases seen) extending obliquely upwards and inwards behind the transversalis fascia to the outer border of the rectus. A triangular space is thus mapped out by the artery, Poupart's ligament, and the outer border of the rectus. This receives the name of the *triangle of Hesselbach.* The floor of the



space is formed by the posterior wall of the inguinal canal, and chiefly by that part of it which is composed of the conjoined tendon.

In the female the inguinal canal is much smaller than in the male. It has the same boundaries, and it is traversed by the round ligament of the uterus.

Arteries of the Abdominal Wall.—In the abdominal wall we find the following arteries :—

(1.) The intercostal and lumbar arteries.
(2.) The deep epigastric.
(3.) The deep circumflex iliac.
(4.) The superior epigastric. ([illegible])
(5.) The musculo-phrenic.

The *intercostal arteries* of the three lower spaces are prolonged forwards between the internal oblique and the transversalis. They have already been noted accompanying the corresponding nerves. In front they anastomose with the epigastric arteries, whilst inferiorly they effect communications with the lumbar arteries.

The abdominal branches of the *lumbar arteries* are usually four in number, and ramify between the same two muscles as the preceding vessels, but at a lower level in the abdominal wall. Anteriorly they anastomose with the epigastric arteries; above with the intercostal arteries; and below with the deep circumflex iliac and the ilio-lumbar.

It is rare to find the intercostal and lumbar arteries injected in an ordinary dissecting-room subject.

The Deep Epigastric Artery, a branch of the external iliac, is a vessel of some size, and takes origin about a quarter or half-an-inch above Poupart's ligament. At present it is seen shining through the fascia transversalis and forming the outer boundary of Hesselbach's triangle. Divide the fascia transversalis along its course and it will be seen to be accompanied by two veins. Study the *course* and *relations* of this vessel. At first it descends to the level of Poupart's ligament, and then curves forwards so as to reach the anterior aspect of the peritoneum. It is now directed upwards and inwards to the deep surface of the rectus. Here it enters the rectal sheath, and proceeding vertically upwards, ends near the lower margin of the thorax in branches which sink into the substance of the muscle and anastomose with the superior epigastric and intercostal arteries.

In the first part of its course, the deep epigastric lies in the extra-peritoneal fat between the peritoneum and the fascia transversalis. It soon, however, pierces the fascia, and, passing in front of the fold of Douglas, ascends between the rectus muscle and the posterior lamella of its sheath. These are its immediate relations, but there are others of equal importance—viz., (1.) as it runs upwards it lies close to the inner side of the internal abdominal ring; (2.) as the spermatic cord traverses the inguinal canal it lies in front of this artery, only separated from it by transversalis fascia; (3.) as the vas deferens passes from the inguinal canal into the abdominal cavity it hooks round the outer side of the artery; (4.) and lastly, before the vessel reaches the rectus muscle it lies unde cover of the internal oblique and transversalis muscles.

The branches which spring from the deep epigastric are—

(1.) Cremasteric.
(2.) Pubic.
(3.) Cutaneous.
(4.) Muscular.

The cremasteric is a small twig which supplies the cremaster muscle and anastomoses with the spermatic artery. *The pubic*, also insignificant in size, goes to the back of the pubes, where it anastomoses with a small branch from the obturator. The importance of this branch arises from the fact that the anastomosis which it establishes sometimes becomes so large as to take the place of the obturator artery. *The muscular* branches are given to the substance of the rectus, and the *cutaneous offsets* pierce the abdominal muscles and anastomose with the superficial epigastric artery.

The deep circumflex iliac springs from the outer side of the external iliac artery, about the same level as the deep epigastric, and runs outwards behind Poupart's ligament to the anterior superior spine of the ilium. From this point onwards it takes the crest of the ilium as its guide, and ends by anastomosing with the ilio-lumbar artery. At first it is placed in the extra-peritoneal fat, and consequently it lies between the fascia transversalis and the peritoneum. Its course behind Poupart's ligament is indicated by a whitish line, which marks the union of the fascia transversalis and fascia iliaca; and if the former fascia be now divided along this line, the deep circumflex iliac will be exposed. At the crest of the ilium the vessel pierces the fascia transversalis, and lies between this and the transversalis muscle; and lastly, about the middle point of the iliac crest it pierces the transversalis muscle, and its terminal twigs ramify between it and the internal oblique. In this manner, then, the artery gradually approaches the surface as we trace it from its origin to its termination, and its relations may be expressed thus:—

(1.) Between fascia transversalis and peritoneum.
(2.) Between fascia transversalis and transversalis muscle.
(3.) Between transversalis muscle and internal oblique muscle.

The dissector has already seen the *ascending branch* which it sends upwards between the internal oblique and transversalis muscles.

Superior Epigastric and Musculo-phrenic Arteries are the two terminal branches of the internal mammary. The *superior epigastric* will be found behind the rectus muscle and within the upper part of its sheath. It gives twigs to the rectus, and anastomoses with the deep epigastric.

The musculo-phrenic can only be seen by reflecting the transversalis from the ribs. It will be found at the level of the eighth rib. From this it proceeds downwards and backwards, along the attachment of the diaphragm to the last intercostal space. It gives branches to the diaphragm and others (the anterior intercostals), which enter the lower intercostal spaces.

When the transversalis fascia is reflected the only layers which intervene between the dissector and the abdominal cavity are the extra-peritoneal fatty tissue and the parietal peritoneum.

If the subject be a male, now is the best time for the student to examine the constitution of the scrotum, spermatic cord, and testicle. This can only be done at present on the right side, as the parts on the opposite side must be kept *in situ* for the study of hernia. After this, however, the dissection can be repeated on the left side.

Scrotum.—This is a pendulous purse-like arrangement of the skin and superficial fascia for the lodgment of the testicles. The skin composing it is of a dark colour and rugose, and is traversed along the middle line by a median raphe or ridge, an indication of its bilateral character.

When the skin is removed the superficial fascia is observed to possess certain characters peculiar to itself. It has a ruddy colour, and is totally devoid of fat. The ruddy tint is due to the presence of involuntary muscular fibres, which take the place of the fat, and constitute what is called the *dartos muscle*. The rugosity of the scrotal skin is maintained by these muscular fibres. But further, the superficial fascia forms in the interior of the scrotum an imperfect septum or partition, which divides it into two chambers—one for each testicle. These points in connection with the construction of the scrotum have all, to a certain degree, been noted in the dissection of the perineum.

But these two scrotal tunics are not the only coverings of the testicle. Each constituent of the abdominal wall has been seen to contribute an investment to the spermatic cord, and this in turn is continued down so as to clothe the testicle. Presuming, then, that the skin and superficial fascia are reflected, the testicle and cord within the scrotum will still be found to be invested by—

(1.) The external spermatic or intercolumnar fascia from the aponeurosis of the external oblique.

(2.) The cremasteric fascia—the muscular element of which is partly derived from the internal oblique.

(3.) The infundibuliform fascia from the fascia transversalis.

The dissectors will find it difficult to demonstrate in every case these different investments of the testicle.

In cases of large herniæ of old standing, however, they become thickened, and can easily be separated.

From the above description the student will understand that there is only *one* tunic common to both testicles—viz., the integument; that the superficial fascia and dartos, and the investments derived from the abdominal wall, constitute special tunics for each testicle.

Spermatic Cord.—The spermatic cord has been seen entering the inguinal canal through the internal abdominal ring; it has been followed as it traverses the canal, and it has been observed to issue from it through the external abdominal ring. It is now seen as it lies within the scrotum suspending the testicle.

Before dissecting out the constituent parts of the cord, turn your attention for a little to the extra-peritoneal fatty tissue which lies behind the internal abdominal ring. Note that a process of this tissue is prolonged downwards with the cord. Now with the handle of the knife gently separate the extra-peritoneal fat from the subjacent peritoneum. You will observe that behind the internal abdominal ring the peritoneum shows a slight bulging forwards, and perhaps you may be able to detect a slender fibrous band passing into the cord from the most prominent part of this bulging. This fibrous cord is the remains of the tube of peritoneum, which in the fœtus connected the serous investment of the testicle (the tunica vaginalis) with the general peritoneal lining of the abdomen. In some cases it may be traced as far as the testicle, but more commonly it only extends down the cord for a short distance; indeed it is frequently absent.*

The coverings of the spermatic cord should now be removed, and the parts which enter into its formation isolated from each other. The following are the structures which must be looked for:—

* To obtain a proper conception of the nature of this fibrous cord it is necessary that we should trace the history of the testicle in the fœtus. Up to a comparatively late period of intra-uterine life the testicle is situated within the abdominal cavity. It lies upon the psoas muscle immediately below the kidney, and is invested by peritoneum.

Between the *fifth* and *sixth months* of fœtal life the testicle begins to descend upon the posterior abdominal wall. It retains its peritoneal investment, and at the *seventh month* it has reached the internal abdominal ring. It now pushes its way through this aperture, pouching out and carrying before it the parietal peritoneum. During the *eighth month* it traverses the inguinal canal, and at the end of the *ninth month* it reaches the bottom of the scrotum.

The testicle, therefore, in its descent has a double relation to the peritoneum—viz.: (1.) it carries with it its own proper investment; (2.) it pushes down before it a portion of the parietal peritoneum, so as to form a diverticulum of the peritoneal sac within the scrotum. In quadrupeds this diverticulum always remains, and freely communicates with the abdominal cavity. In the human subject the lower part of the diverticulum, which holds the testicle, is alone retained; the upper part is obliterated, and no trace is left beyond the fibrous cord mentioned in the text. In this manner, then, the tunica vaginalis of the testicle is formed—its original peritoneal covering remaining as the *visceral* or *testicular part*, and the lower portion of the diverticulum derived from the parietal peritoneum being retained as the *parietal or scrotal part* (*vide* description of tunica vaginalis, p. 98).

The orifice by which the abdominal peritoneal cavity communicates with the scrotal peritoneal diverticulum is usually closed before birth, and the upper part of the diverticulum, from the internal abdominal ring to the upper end of the testicle, is generally obliterated in the first month of extra-uterine life. In a few cases, however, the obliteration is only partial, or indeed it may fail to take place at all, thus giving rise to a great liability to congenital hernia or congenital hydrocele.

(1.) The vas deferens.

(2.) Blood-vessels.
- Arteries.
  - The spermatic.
  - The cremasteric.
  - The artery to the vas deferens.
- Veins.
  - The spermatic plexus of veins.

(3.) Lymphatics.

(4.) Nerves.
- Genital branch of the genito-crural.
- Sympathetic twigs.

These are all held together by loose areolar tissue, which intervenes between them, and also by the investments which are given to the cord by the abdominal wall.

The cremasteric artery is a branch of the deep epigastric, and has already been seen entering the cremaster muscle. The *genital branch* of the genito-crural nerve has a similar destination. It has also been displayed in a previous stage of the dissection.

The spermatic artery arises within the abdomen from the front of the aorta, and entering the cord at the internal abdominal ring, it proceeds to the testicle, into the posterior border of which it sinks, after dividing into several smaller twigs. The *spermatic veins* issue from the testicle at its posterior border, and as they pass upwards they form in the cord a bulky plexus, which is termed the *spermatic plexus.* A single vessel issues from this, which enters the abdomen through the internal abdominal ring. On the right side it pours its blood into the inferior vena cava; on the left side it joins the left renal vein.

The vas deferens, the duct of the testicle, can always be distinguished by the hard, firm, cord-like sensation which it gives when the spermatic cord is held between the finger and thumb. It ascends along the posterior part of the cord. At the internal abdominal ring, however, it separates from the spermatic vessels, and lies to their inner side, and as it enters the abdomen it hooks round the deep epigastric artery.

The artery to the vas deferens is a small branch from the superior vesical. It follows the duct to the testicle.

The sympathetic filaments extend downwards upon the spermatic artery. They come from the renal and aortic plexuses.

The spermatic lymphatics enter the abdomen through the internal abdominal ring, and join the lumbar glands.

The Testicle.—The testicle should next be examined. First note its position in the scrotum. It lies somewhat obliquely, with its upper end directed forwards and outwards, and its lower end backwards and inwards. The left testicle hangs at a lower level than the right.

The spermatic cord should now be divided, and the testicle removed from the scrotum. When this is done it will be noticed that the organ has still another investment to be considered—viz., *the tunica vaginalis.*

The tunica vaginalis is a serous sac, and consequently presents a *parietal* or *scrotal* portion, and a *visceral* or *testicular* portion. Its extent can be demonstrated in a striking manner by making a small aperture in the parietal part, and then introducing a blow-pipe into the serous cavity and inflating it with air. It will be seen to be considerably larger than the gland which it envelopes. It ascends for some distance upon the spermatic cord, and it even descends beyond the testicle. When flaccid, the parietal

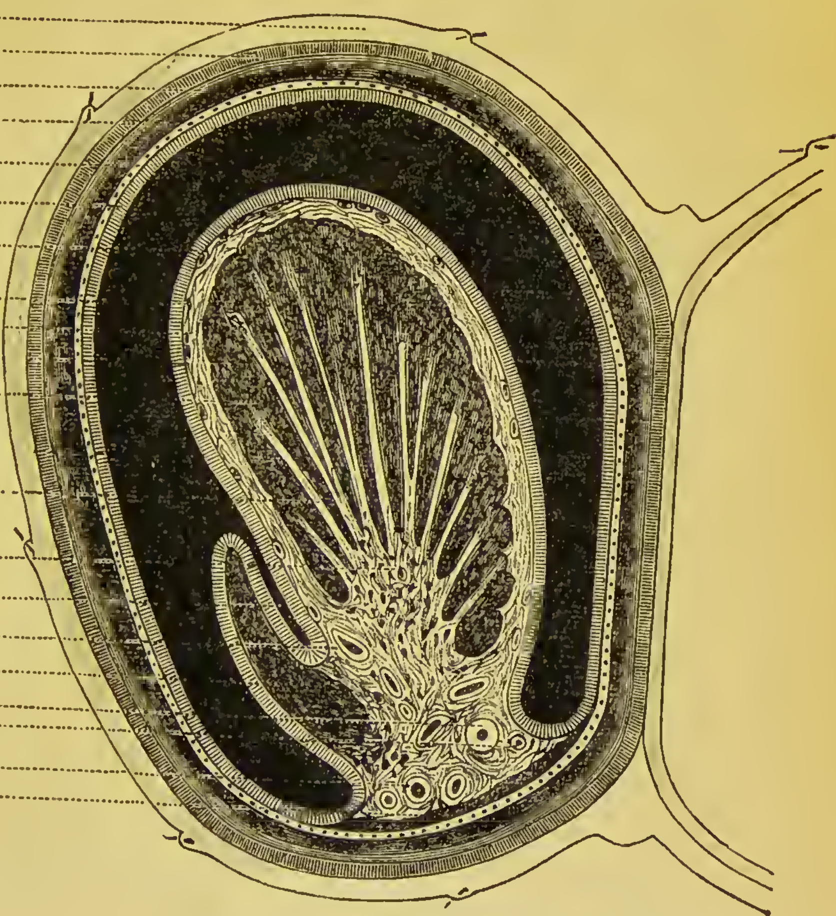


Fig. 14.

Transverse section through the left side of the scrotum and the left testicle. The sac of the tunica vaginalis represented in a distended condition.

part is simply wrapped loosely over the visceral portion which adheres to the surface of the testicle.

Open into the sac of the tunica vaginalis by running a pair of scissors along the anterior aspect of the parietal part. On folding back the parietal portion of the tunica vaginalis the form of the testicle may be studied, and also the manner in which the testicle is clothed by the visceral layer.

The testicle is an oval body, with flattened sides. The posterior border is also somewhat flattened, and here we see the *epididymis*. This is an elongated and arched structure, which is adapted to the upper end and outer side of the posterior border of the testicle. Its upper end is enlarged, and is termed the *globus major*; its lower end is called the *globus minor*, and the intervening portion, which is narrow, receives the name of the *body of the epididymis*. The globus major is directly attached to the upper end of the testicle, which it surmounts like a helmet, by the vasa efferentia, which pass from the one into the other. The *globus minor* is merely fixed to the back of the testicle by areolar tissue, whilst *the body* is free.

The vas deferens emerges from the lower end of the globus minor, and then passes upwards upon the posterior border of the testicle and to the inner side of the epididymis. By this relation, the side to which a given testicle belongs can be readily detected. The vessels have already been seen entering the posterior border of the testicle.

Having learned these points concerning the testicle, the student is in a position to trace the visceral layer of the tunica vaginalis upon its surface. Observe that it envelopes it closely on every side, with the exception of the posterior border, where the vessels enter. The posterior aspect of the epididymis is also, to a certain extent, left bare. Follow it backwards over the outer surface of the organ, and it will be seen to form a little *cul-de-sac* between the body of the epididymis and the testicle. This is called the *digital fossa.* Note particularly that it is along the posterior border of the testicle that the parietal part becomes continuous with the visceral part.

Surgical Anatomy.—To the surgeon the anatomy of the abdominal wall is chiefly of interest from the bearing which it has upon **Hernia** or **Rupture.**

Hernia abdominis may be defined as being the protrusion of any viscus or portion of a viscus through the wall of the abdomen. There are three localities in which, from natural weakness of the parietes, this protrusion is specially liable to occur—(1.) through the external abdominal ring, which gives passage to the spermatic cord in the male, and the round ligament of the uterus in the female; (2.) through the crural canal or innermost compartment of the femoral sheath, within which certain lymphatic vessels ascend from the thigh into the abdominal cavity; (3.) through the umbilicus or the foramen in the linea alba of the fœtus, which transmits the constituents of the umbilical cord. These different forms of hernia are distinguished by the terms—*inguinal*, *femoral*, and *umbilical.*

There are other situations at which hernial protrusions occur, but so rarely that it would be out of place to take notice of them here.

Inguinal Hernia.—The inguinal canal is not so great a source of weakness to the abdominal wall as might, at first sight, be expected, and this chiefly on account of its obliquity of direction. The inlet or internal abdominal ring is situated a long way (fully an inch and a-half) to the outer side of the outlet or external abdominal ring. The canal is therefore distinctly valvular; the greater the force with which the viscera are pressed directly against the inguinal part of the abdominal parietes, the more firmly will the posterior wall of the canal be pressed against the spermatic cord and the anterior wall.

On the *left side* of the body the parts related to inguinal hernia have been retained in position. The student should, therefore, make a dissection of the inguinal region, with special reference to hernia. Begin by reflecting the aponeurosis of the external oblique. Make a vertical incision through it parallel to the outer border of the rectus, and carry it downwards on the inner side of the internal pillar of the external abdominal ring. The aponeurosis can thus be thrown downwards and outwards, and the external ring, at the same time, preserved. The internal oblique, cremaster, and conjoined tendon should now be cleaned, and their precise relations to the spermatic cord studied. Notice that the fleshy lower border of the internal oblique overlaps the upper part of the cord, whilst, towards the outlet of the inguinal canal, the conjoined tendon lies behind the cord. Next replace the aponeurosis of the external oblique, and, introducing the point of the fore-finger into the external abdominal ring, press directly backwards. Observe that it rests upon the conjoined tendon; that, in fact, this tendon and the fascia transversalis alone intervene between the finger and the extra-peritoneal fatty tissue and the peritoneum. The lower part of the internal oblique muscle should now be separated from the transversalis by insinuating the handle of the knife between them. When this is done, divide the internal oblique close to Poupart's ligament, and throw it forwards. At the same time, make a longitudinal incision through the cremaster muscle, and turn it aside from the surface of the cord.

All further dissection must be effected from the inside. Divide the abdominal wall horizontally from side to side at the level of the umbilicus. Raising the lower part of the abdominal wall and examining its posterior surface, the student will observe three peritoneal ridges or falciform folds radiating from the umbilicus as from a centre, and proceeding towards the pelvis. These are caused by the presence of three fibrous cords,—the remains of the urachus, and the two obliterated hypogastric arteries,—in the extra-peritoneal fatty tissue. The *urachus* occupies the middle line, and extends downwards to the apex of the bladder. The *obliterated hypogastric artery* proceeds downwards and outwards on each side so as to gain the side of the bladder. It lies to the inner side of the internal abdominal ring.

By these ridges two fossæ are formed on each side of the middle line close to Poupart's ligament. They are termed the *external* and *internal inguinal* pouches, and are regarded as determining, to a certain extent, hernial protrusions in the inguinal region. The external inguinal pouch is placed on the outer side of the obliterated hypogastric artery, and the internal abdominal ring is situated in relation to its *lower* and *inner* part. The internal inguinal pouch, neither so deep nor so large as the outer fossa, lies between the ridges formed by the obliterated hypogastric artery and the urachus.

It is important also to determine the relation which the obliterated hypogastric artery holds to the deep epigastric artery. Both ascend in the abdominal wall between the peritoneum and the fascia transversalis, and sometimes they lie parallel and close to each other in the peritoneal fold, which separates the two inguinal pouches from each other. In the majority of cases, however, the obliterated vessel lies a short distance to the inner side of the deep epigastric artery, and, in this case, a third small fossa may be apparent between them. This pouch is called the *middle inguinal pouch.* The student has already seen in the dissection of the abdominal wall that the epigastric artery, together with Poupart's ligament and the outer border of the rectus, bound a triangular space termed Hesselbach's triangle. Recalling this fact, he will understand that when the obliterated hypogastric artery lies to the inner side of the deep epigastric, it must ascend in relation to the posterior aspect of the floor of the triangle and cut the space into two.

Having determined these points, the dissector can proceed as follows :—Divide the lower part of the abdominal wall in a vertical direction along the linea alba, from the umbilicus to the pubes. Make this incision a little on one side of the urachus, and, on nearing the pubes, be careful not to injure the bladder, which may project upwards beyond it. On throwing the left flap downwards and outwards, it may be possible to detect the position of the internal abdominal ring from the fact that in some cases the peritoneum is slightly dimpled into it. This dimple or depression is termed the *digital fossa.* Now strip the peritoneum from the flap as far down as Poupart's ligament. This can be easily done with the fingers, as its connection with the extra-peritoneal fatty tissue is very slight. Next separate the extra-peritoneal fatty tissue from the fascia transversalis with the handle of the knife, proceeding with great care as you approach Poupart's ligament. The *internal abdominal ring*, or the inlet of the inguinal canal, is now seen from within. From this point of view the opening is more like a vertical slit in the fascia transversalis than a ring. Note the deep epigastric artery passing upwards and inwards close to its inner margin. Further, observe the vas deferens and the spermatic vessels entering it, the former hooking round the epigastric artery as it disappears into the canal. Introduce the tip of the little finger into the opening and push it gently downwards in the direction of the inguinal canal. On raising the flap of the abdominal wall and looking from the front, a very striking demonstration of the infundibuliform fascia can thus be obtained.

There are *two* forms of *Inguinal Hernia*—viz., *oblique* and *direct*. *Oblique inguinal hernia* follows the course of the spermatic cord. The protrusion traverses the entire length of the inguinal canal; entering at the inlet or internal abdominal ring, and emerging (when the hernia is complete) at the outlet or external abdominal ring. *Direct inguinal hernia* only traverses the lower part of the inguinal canal. It pushes before it or bursts through that part of the posterior wall of the canal which forms the floor of Hesselbach's triangle, and, having thus gained the interior of the canal by a short cut, it emerges like the oblique variety at the external abdominal ring.

The *deep epigastric artery* bears a different relation to each of these forms of hernia. This vessel lies close to the inner margin of the internal abdominal ring, and it forms the outer boundary of Hesselbach's triangle; consequently, in oblique inguinal hernia, the protrusion, as it enters the inguinal canal, lies *external* to the vessel, whilst, in direct inguinal hernia, it lies *internal* to it. So important are these relations, that the terms *external* and *internal* are frequently employed to denote the two forms of inguinal hernia instead of *oblique* and *direct*.

It is also essential that the student should determine the relation which these forms of hernia hold to the inguinal pouches of peritoneum. In *oblique inguinal hernia* the protrusion invariably leaves the abdominal cavity at the lower and inner part of the *external inguinal pouch*. It is here that the internal abdominal ring is situated.

In the case of direct inguinal hernia the protrusion may leave the abdominal cavity either from the *middle* or from the *internal inguinal pouch*, both of which are in relation to the floor of Hesselbach's triangle.

In almost every case a hernial protrusion in passing to the surface carries before it a portion of the parietal peritoneum, which constitutes its immediate covering, and is termed by surgeons the *sac* of the hernia. In *oblique inguinal hernia* the other coverings which the protrusion acquires are identical with those of the spermatic cord. Entering the internal abdominal ring, it receives an investment from the infundibuliform fascia; emerging from the lower border of the internal oblique, it acquires a cremasteric covering; and, coming out through the external

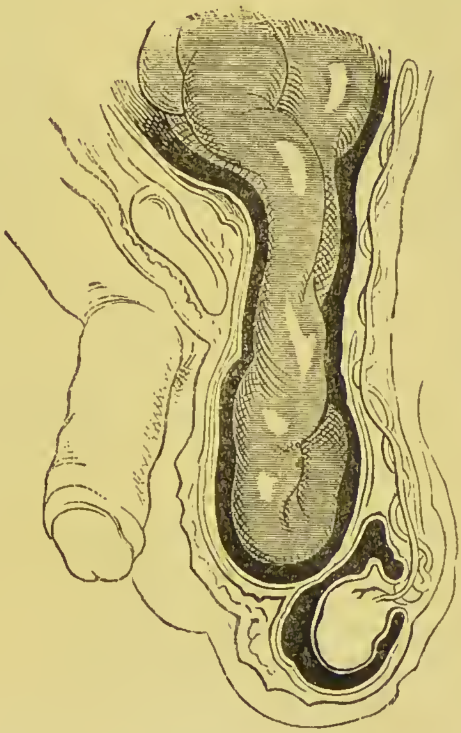


FIG. 15.

To show the relation of parts after an ordinary inguinal hernia has reached the bottom of the scrotum. The testicle occupies the lowest and back part of the scrotum, and the cord is placed behind the protrusion.—*From* SPENCE'S *Surgery*.

abdominal ring, it obtains the external spermatic or intercolumnar fascia. From the surface, then, to the peritoneal sac, the following are the coverings of an oblique inguinal hernia:—

(1.) Skin and superficial fascia.
(2.) Intercolumnar or external spermatic fascia.
(3.) Cremasteric fascia.
(4.) Infundibuliform fascia.
(5.) Extra-peritoneal fatty tissue.
(6.) Parietal peritoneum, constituting the hernial sac.

In *direct inguinal hernia* the coverings of the protrusion differ according to the part of Hesselbach's triangle through which it projects. If the student examine the floor of this triangular area, he will observe that the conjoined tendon does not stretch over its entire extent; that, towards the outer part of the space, the transversalis fascia alone forms the floor. When a direct hernia leaves the abdomen from the middle inguinal pouch, it is through this outer part of Hesselbach's triangle that it protrudes, and, in this case, the coverings are almost identical with those of oblique hernia.

(1.) Skin and superficial fascia.
(2.) Intercolumnar or external spermatic fascia.
(3.) Cremasteric fascia (as a general rule).
(4.) Transversalis fascia.
(5.) Extra-peritoneal fatty tissue.
(6.) Parietal peritoneum or sac.

This form of direct hernia is comparatively rare. The more common form of direct hernia leaves the abdomen from the internal inguinal pouch, and pushes its way through the inner part of Hesselbach's triangle. It therefore acquires a covering from the conjoined tendon. The following are its investments :—

(1.) Skin and superficial fascia.
(2.) Intercolumnar or external spermatic fascia.
(3.) Conjoined tendon.
(4.) Transversalis fascia.
(5.) Extra-peritoneal fatty tissue.
(6.) Parietal peritoneum or hernial sac.

When the conjoined tendon is feeble, or when a direct hernia takes place suddenly, the protrusion may burst through it, in which case it does not obtain a covering from this source.

There are two special varieties of oblique inguinal hernia which it is necessary to mention—viz., *congenital* hernia and *infantile* hernia.

Congenital hernia occurs when the communication, existing in the fœtus, between the peritoneal cavity and the interior of the tunica vaginalis, remains freely open. Fig. 16 gives a good idea of the state of the parts which allows such a hernia to take place, whilst Fig. 17 shows the position of the protrusion after it has descended into the cavity of the tunica vaginalis.

Infantile hernia occurs where the obliteration of the communication between the interior of the tunica vaginalis and the peri-

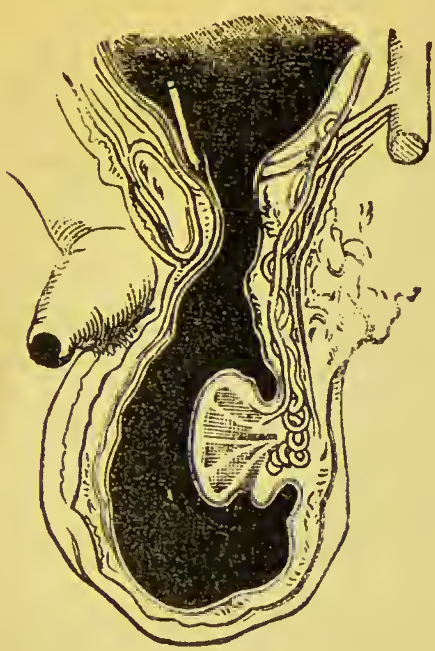
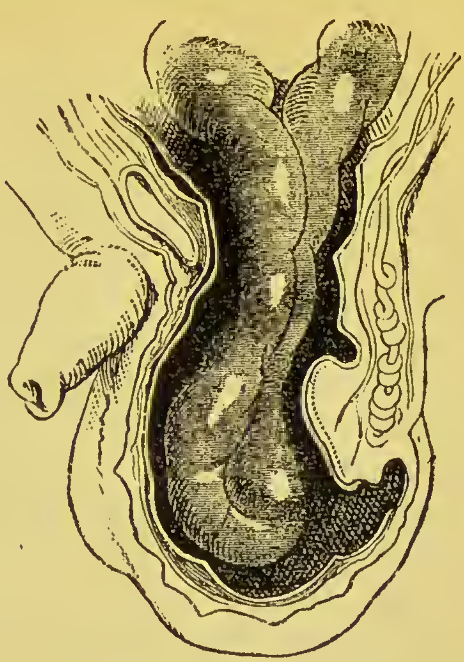


FIG. 16.
To show the congenital condition of parts which leads to the occurrence of congenital hernia.—*From* SPENCE'S *Surgery*.



FI 17.
Congenital hernia.—*From* SPENCE'S *Surgery.*

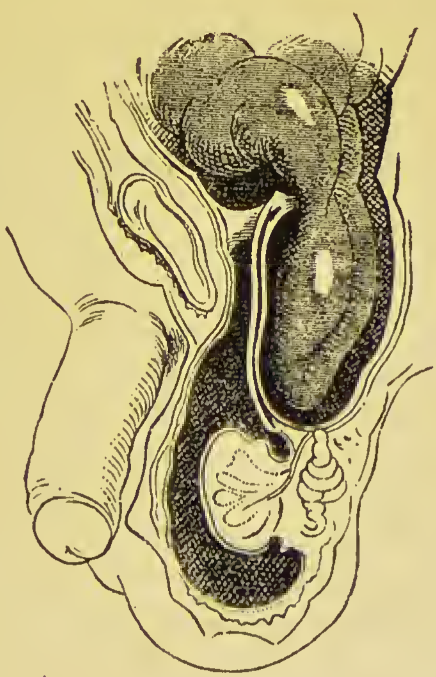


FIG. 18.
Infantile hernia.—*From* SPENCE'S *Surgery.*

toneal sac is only partial. In this case, the tunica vaginalis remains very large, and extends upwards into the inguinal canal. The hernial protrusion in its descent lies behind it.

Femoral Hernia.—This consists in the protrusion of a viscus or part of a viscus from the abdominal cavity into the region of the thigh. In its descent it passes *behind* Poupart's ligament along the *crural canal* or *innermost compartment* of the femoral sheath. It is consequently mainly the duty of the student who is engaged in the dissection of the lower limb, and within whose domain the femoral sheath lies, to investigate the anatomical connections of this variety of hernia. Still it is very necessary that the dissector of the abdomen should examine, from its abdominal aspect, the *crural ring* or aperture of communication between the crural canal and the abdominal cavity, and give the dissector of the lower limb an opportunity of doing so likewise.

The *crural ring* is placed immediately behind Poupart's ligament, in the interval between the external iliac vein and the base of Gimbernat's ligament. If the peritoneum is still in position at this point it may exhibit a slight digital depression as it passes over the ring. Strip the peritoneum from the greater part of the iliac fossa. The extra-peritoneal fatty tissue, which stretches over the crural ring will be observed to be denser, stronger, and more fibrous than elsewhere. A special name is applied to this small portion of the extra-peritoneal fatty tissue. Seeing that it is applied to the ring in such a manner as to close the crural canal at its abdominal end, it is called the *septum crurale.* The extra-peritoneal fatty tissue should now be dissected back with the handle of the knife, to the same extent as the peritoneum. The *fascia iliaca* clothing the iliacus and psoas muscles is thus exposed, and the dissector should note that the external iliac vessels lie *upon* and not *behind* this fascia.

The student is now in a position to study the manner in which the *crural ring* is formed. Let him follow the fascia iliaca and the fascia transversalis towards Poupart's ligament. If the dissection has been carefully performed, he will observe that to the outer side of the external iliac vessels these two fasciæ become directly continuous with each other, and, further, that along the line of union they are both firmly attached to Poupart's ligament. It is evident, then, that no hernial protrusion could leave the abdominal cavity behind Poupart's ligament and external to the iliac vessels.

Opposite the iliac vessels the arrangement of the fascia will be found to be very different. Here the fascia iliaca is carried downwards behind the vessels, whilst the fascia transversalis is prolonged downwards in front of the vessels and behind Poupart's ligament. In the region of the thigh they together constitute a funnel-shaped sheath for the femoral artery and vein, and for some lymphatics ascending to the abdomen. This sheath is divided into three compartments by two vertical partitions. The femoral artery occupies the outermost compartment, and the vein the middle compartment, whilst the innermost compartment, called the crural canal, is occupied by the lymphatics, and sometimes by a small lymphatic gland.

An essential difference between these compartments is this —that whilst the two outer are completely filled up by the artery and vein, the crural canal is much wider than is necessary for the passage of its contents. Gauge the width of the crural ring by introducing the point of the little finger. It is readily admitted within the opening. Here, then, is a source of weakness to the abdominal wall, and one which is greater in the female than in the male, seeing that the distance between the iliac and pubic spines is proportionally greater, and, in consequence, the crural ring wider.

When the finger is within the ring, mark the structures which surround it—*in front*, Poupart's ligament, with the spermatic cord or round ligament of the uterus; *behind*, the ramus of the pubis, giving origin to the pectineus muscle, which is covered by the pubic portion of the fascia lata; *internally*, the sharp crescentic free border of Gimbernat's ligament; and *externally*, the external iliac vein.

It is still more necessary to note the relations of the blood-vessels to the crural ring. The *external iliac vein* has been seen to lie to its outer side. The *deep epigastric artery*, as it ascends on the posterior aspect of the abdominal wall, is close to its upper and outer margin, and sends its *pubic* branch inwards in front of it. More important than any of these is the relation of the *obturator artery*, when it takes origin from the deep epigastric. This anomalous vessel may adopt one of two courses—(1.) It may follow the course of the pubic artery, an enlarged form of which it in reality is, and pass inwards *in front* of the ring, and then descend along its *inner* margin. In this case, the ring is surrounded on all sides, except posteriorly, by vessels. (2.) It may run downwards between the ring and the external iliac vein.

Internal to the crural sheath the passage of a hernial protrusion behind Poupart's ligament is effectually prevented by Gimbernat's ligament.

Femoral hernia is most common in females, and inguinal hernia in males; and for the very evident reason, that in the female the crural canal is relatively larger, whilst in the male the passage of the spermatic cord weakens the inguinal region more than the passage of the small round ligament of the uterus.

Umbilical Hernia.—Very little need be said regarding this form of hernia. In the fœtus and infant the protrusion emerges through the umbilical orifice; in the adult, it usually pushes its way through the linea alba close to the umbilicus.

The Penis.—The penis has already, to a certain extent, been studied in the dissection of the perineum (p. 17). It has been seen to be composed of the *two corpora cavernosa* and the *corpus spongiosum.* Posteriorly, the corpora cavernosa separate from each other, become tapered and are attached to the sides of the pubic arch under the name of the *crura penis;* anteriorly, they together form a blunt rounded extremity, which is covered by the glans penis. The corpus spongiosum, when traced backwards into the perineum, expands into the *bulb of the penis,* which is attached, in the mesial plane, to the anterior aspect of the triangular ligament; traced forwards to the extremity of the penis, it is again found to expand into the *glans penis,* which fits like a cap upon the rounded ends of the corpora cavernosa. The glans penis is somewhat conical in shape, and the projecting margin of its base is termed the *corona glandis.* The urethra opens at the extremity of the glans by a vertical fissure, called the *meatus urinarius.*

The integument of the penis is remarkable for its great delicacy and elasticity, and the absence of hairs. It has a brownish tint, and is freely moveable over the organ. At the glans the skin leaves the body of the penis, and, passing for a variable distance over the glans, is folded back upon itself so as to form the *prepuce.* The deep layer of the prepuce reaches the penis again behind the corona glandis, and is then reflected forwards over the glans to become continuous with the mucous membrane of the urethra at the meatus urinarius. A slight fold will be observed on the under surface of the glans, extending from the lower angle of the urinary orifice to the prepuce; this is the *frænum preputii.*

Reflect the integument from the surface of the penis by making a longitudinal incision along the middle line of the dorsum. The superficial fascia will then be seen to be composed of a quantity of loose areolar tissue. We never find fat in the meshes of this tissue. The suspensory ligament and the dorsal vessels and nerves of the penis should now be dissected.

Suspensory Ligament.—The suspensory ligament is a strong fibro-elastic band of a triangular shape. By its posterior border it is attached to the symphysis pubis. Towards the penis it separates into two lamellæ, which join the body of the organ, and between which are placed the dorsal vessels and nerves. The anterior borders of the two lamellæ are free, and look forwards.

Dorsal Vessels and Nerves.—On the dorsum of the penis, in the groove which extends along the middle line between the two corpora cavernosa, is the *dorsal vein;* on each side of this is the *dorsal artery*, and superficial and external to the artery is the *dorsal nerve.* On the dorsum of the penis, therefore, we find *one* vein, *two* arteries, and *two* nerves.

The dorsal vein of the penis begins by several twigs from the glans and prepuce. It extends backwards in the middle line, and disappearing between the two layers of the suspensory ligament, pierces the triangular ligament midway between the symphysis pubis and the urethra. Reaching the pelvis, it joins the prostatic plexus of veins. [illegible]

The dorsal arteries are the terminal twigs of the internal pudic vessels. Piercing the triangular ligament, they pass forward between the two layers of the suspensory ligament, and continuing their course on the dorsum of the penis, they terminate in branches for the glans penis.

The dorsal nerves are branches of the internal pudic. They have a similar course to the arteries, and end in fine twigs to the papillæ of the glans.

ABDOMINAL CAVITY.

The abdominal cavity may now be opened completely by carrying an incision from the umbilicus upwards to the ensiform cartilage. On throwing the two flaps thus formed upwards and outwards over the lower margin of the thorax, a strong fibrous cord, *the obliterated umbilical vein*, will be observed extending from the umbilicus to the under surface of the liver. The obliterated umbilical vein also receives the name of the *round ligament*, or *ligamentum teres*, of the liver. As it ascends towards that organ, it gradually recedes from the posterior surface of the abdominal wall, taking with it a fold of peritoneum, termed the *falciform ligament* of the liver.

Shape and Boundaries of the Abdominal Cavity.—The abdominal cavity is ovoid in shape, its vertical diameter being the longest. *Superiorly*, it is roofed by the dome-shaped diaphragm, which presents a deep concavity towards the abdomen. *Inferiorly*, it is floored by the pelvic diaphragm, which is formed by the levatores ani and the coccygei muscles, and which is also concave towards the abdominal cavity. Neither the roof nor the floor are complete and unbroken. The diaphragm is perforated by certain structures which pass between the thorax and the abdomen. The continuity of the pelvic diaphragm is broken by the passage of certain structures between the pelvic division of the abdominal cavity and the perineum. *Posteriorly*, the cavity of the abdomen is bounded by the lumbar vertebræ and the sacrum, and on each side of the spine by the psoas and quadratus lumborum muscles. *Anteriorly*, it is bounded above by the ensiform cartilage and the cartilages of the lower true ribs, below by the pubic bones and the symphysis pubis, and between by the linea alba, the recti and pyramidales muscles, and the aponeuroses of the flat muscles of the abdomen. *Laterally*, it is bounded above by portions of the seven lower ribs, below by the iliac and ischial portions of the innominate bones, and between by the flat muscles of the abdomen.

From this it will be seen that the roof, floor, and by far the greater part of the abdominal wall are composed of muscular structures, the contraction of which would diminish the capacity of the cavity, and subject the contained viscera to compression.

Subdivision of the Abdominal Cavity.—In dealing with so large a cavity, and one which contains such a diversity of contents, it is absolutely necessary for anatomists to subdivide it into regions, in order that the precise position of each viscus may be accurately defined. In making the first subdivision we take advantage of the brim of the true pelvis. That part of the cavity which is situated above this is termed **the abdomen proper**; whilst that part which lies below it is called **the pelvic cavity.**

A further subdivision is effected in the case of the *abdomen proper* by means of arbitrary lines. *Two horizontal lines* are drawn around the body, one at the level of the ninth costal cartilages, and the other at the level of the highest points of the iliac crests. The abdomen is thus mapped out into three zonular regions, which are termed from above downwards—(1.) the *costal* zone; (2.) the *lumbar* zone; and (3.) the *iliac* zone. *Two vertical lines* are now drawn, one upon each side, from the costal cartilage of the eighth rib to the centre of Poupart's ligament, and in this manner each zonular region is subdivided into three. The costal zone is mapped off into a central *epigastric region* and a *right* and *left hypochondriac region;* the lumbar zone into a central *umbilical region* and a *right* and *left lumbar region;* and the iliac zone into a central *hypogastric region* and a *right* and *left iliac region.*

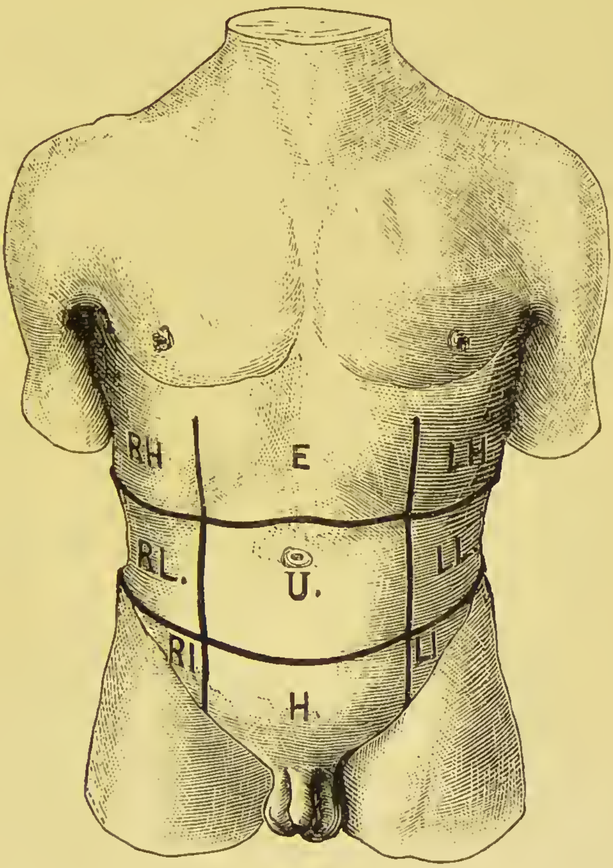


FIG. 19.

R.H. Right hypochondrium.
R.L. Right lumbar region.
R.I. Right iliac region.

E. Epigastric region.
U. Umbilical region.
H. Hypogastric region.

L.H. Left hypochondrium.
L.L. Left lumbar region.
L.I. Left iliac region.

Contents of Abdomen Proper. — Within the abdominal cavity we find the following structures :—

(1.) Abdominal part of the alimentary canal. — Stomach. Small intestine. Large intestine.

(2.) Glands situated outside the walls of the alimentary canal and pouring their secretions into it. — Liver and its gall-bladder or reservoir. Pancreas.

(3.) The spleen.

(4.) The two kidneys, the ureters, and the two suprarenal bodies.

(5.) Lymphatic glands, lymphatic vessels, the receptaculum chyli, and the commencement of the thoracic duct.

(6.) The abdominal aorta, with its various visceral and parietal branches.

(7.) The inferior vena cava and its tributaries, and the commencements of the venæ azygos major and minor.

(8.) The lumbar plexuses of nerves.

(9.) The abdominal portion of the sympathetic nervous system.

(10.) The peritoneal membrane which lines the cavity and invests the viscera.

A mere glance is sufficient to distinguish between the three primary parts of the alimentary canal within the abdominal cavity. The *stomach* is the dilated bag-like portion which lies in the left side of the costal zone. The *small intestine* succeeds the stomach, and presents a striking contrast to the *large intestine.* The following are the leading points of difference:—(1.) The calibre of the small intestine is usually considerably smaller than that of the large intestine. Sometimes, however, the large intestine is very much contracted, so this feature cannot be regarded as an infallible guide. (2.) The walls of the small intestine are smooth and uniform, whereas the walls of the great intestine are puckered and sacculated. (3.) The longitudinal muscular fibres in the wall of the great intestine are not disposed uniformly around the tube as in the small intestine, but are collected into three bands, which are separated from each other by intervals, and are distinctly visible to the naked eye. These bands are shorter than the tube itself, and this is the reason of its walls being puckered. (4.) Attached to the great intestine are *appendices epiploicæ*. These are small peritoneal pouches or folds, which hang from the gut and contain fat.

On opening the abdominal cavity, the student obtains a very partial view of the contained viscera, so long as they are left undisturbed. On the right side of the costal zone the sharp margin of the liver may be observed projecting slightly below the ribs, whilst opposite the ninth costal cartilage the fundus of the gall-bladder is seen peeping out from under cover of this organ, and projecting slightly beyond its anterior border. In the same zone, to the left of the liver, a portion of the stomach is visible, whilst extending downwards from the lower border of this viscus is a broad fold of peritoneal membrane, called the *great omentum*. This usually contains a quantity of fat in its meshes, and is spread out like an apron, so as to hide from view the viscera which occupy the two lower zones. Sometimes, however, the great omentum is narrow and short; or, again, it may be turned more or less completely upwards or to the side. In either case some of the coils of the small intestine will be seen, and also, in all probability, those parts of the great intestine which occupy the right and left iliac fossæ. That part lying in the right iliac fossa is called the *cæcum*, whilst the part situated in the left fossa is the *sigmoid flexure*. It may also chance that the bladder is full, in which case its apex will be observed projecting above the pubes. Lastly, in pregnant females the gravid uterus will be visible, reaching a height in correspondence with the period of gestation.

Raise the great omentum and turn it upwards over the lower margin of the thorax. By this proceeding the coils of the small intestine are fully exposed, and a part of the great intestine which extends across the cavity of the abdomen will be seen shining through the posterior layer of the great omentum. This is the *transverse colon*.

The position and connections of the various viscera should now be studied.

The Liver.—The liver is the largest gland in the body. It is a solid massive organ, the chief bulk of which lies in the right hypochondrium; it also extends into the epigastric region, and even enters for a considerable distance into the left hypochondrium. Its *upper surface* is smooth and convex, and is accurately fitted to the under surface of the diaphragm. Attached to this surface is the falciform ligament, which maps out the organ into a right and left lobe. Pass the hand backwards over the upper surface and you will notice that its *posterior* rounded *border* is in contact with the diaphragm, and bound to it by the peritoneum, which passes from the one to the other. In the male subject the *anterior* sharp *border* projects very slightly, if at all, below the ribs, but in females and children it almost always extends a short distance beyond them. The concave *under surface* is in relation to a number of important structures. Thus the left lobe overlaps the stomach, whilst in contact with the inferior surface of the right lobe are—(1.) the gall-bladder, which is tightly bound down to it by the peritoneum; (2.) the duodenum, or commencement of the small intestine; (3.) the hepatic flexure of the colon; and (4.) the right kidney and suprarenal capsule.

Even in health the position of the liver is variable. From its intimate connection with the diaphragm it is easy to understand how it must rise and fall with every respiratory act. Again, on account of its great weight the posture of the body must have a slight effect upon its position. Displacement of the liver from artificial causes, such as tight lacing in females, is by no means uncommon. In these cases the pressure upon the lower part of the chest forces the liver downwards.

The *gall-bladder* should be examined in connection with the liver. It lies in the right hypochondrium, on the under surface of the right lobe of the liver, to which it is tightly bound by the peritoneum.

The Spleen.—The spleen lies deep in the left hypochondrium, and is altogether out of sight in the undisturbed condition of the viscera. By drawing the stomach to the right, and thrusting the hand into the left hypochondrium, it can readily be discovered and pulled forwards for inspection.

It is a solid organ, oval in form, but somewhat compressed laterally. It lies obliquely in the abdominal cavity; indeed, it is oblique in two directions—viz., from above downwards and outwards, and from above downwards and forwards.

The *superior extremity* of the spleen is attached to the diaphragm by a peritoneal fold, called the *phrenico-splenic* ligament. The *inferior extremity*, which is somewhat pointed, is in relation to the splenic flexure of the colon, and rests upon the *phrenico-colic* ligament, a fold of peritoneum which binds the splenic flexure of the colon to the diaphragm. The *external surface* is smooth and rounded, and lies upon the diaphragm, which intervenes between it and the ninth, tenth, and eleventh ribs—to the curvature of which it is adapted. The *internal surface* is concave, and is connected with the posterior aspect of the fundus of the stomach by a peritoneal fold, called the *gastro-splenic omentum.* This surface shows a longitudinal slit, called the hilus, which gives passage to the vessels and nerves which pass to and from the organ. The stomach overlaps the inner surface of the spleen, and the left crus of the diaphragm and the kidney are in relation to it behind the hilus. The *anterior border* is usually notched. The *posterior border* is thicker than the anterior border.

Stomach.—The stomach is the most dilated part of the alimentary canal, and constitutes the receptacle for the food after it has been masticated and swallowed. It has a somewhat pyriform shape, and is curved upon itself. Of course, its form and position are greatly influenced by the amount of food which it contains.

In all probability, in the subject before you the stomach is empty, and the anterior and posterior walls flattened and in apposition with each other.

When the stomach is distended, however, the surfaces are convex. *The anterior surface* looks forwards and upwards, and is in relation to the under surface of the diaphragm, the under surface of the liver, and the posterior aspect of the anterior abdominal wall. The *posterior surface*, on the other hand, looks backwards and downwards, and is related to the diaphragm, aorta, spleen, pancreas, the third part of the duodenum, and the left kidney and suprarenal capsule. The large rounded end of the stomach is called the *cardiac extremity* or the *fundus*, and is directed upwards so as to rest on the under surface of the diaphragm. The smaller end is termed the *pylorus*. It is directed to the right, and is continuous with the first part of the small intestine (the duodenum)—a slight constriction and thickening of the walls, marking the point at which the one ends and the other begins. The right or upper border of the stomach is called the *lesser curvature*. It is concave, and, if it be followed towards the cardiac end of the organ, the œsophagus will be found entering the stomach at its upper extremity to the right of the fundus. The left or lower border, termed the *greater curvature*, is convex, and much longer than the lesser curvature.

Having examined the form of the stomach, and learned the terms which are applied to the different parts of it, the dissector is able to study its position within the abdominal cavity. It is placed in the costal zone, partly in the left hypochondrium and partly in the epigastric region. The *hypochondriac portion* of the stomach comprises fully three-fourths of the organ, and is vertical in direction, the fundus occupying the highest part of the region. The *epigastric part* of the stomach is transverse in direction, and comprises the remaining one-fourth of the organ. It lies about three-fingers breadth below the ensiform cartilage. It is important to note that the pyloric end of the stomach does not, under ordinary circumstances, extend into the right hypochondrium, but gives place to the duodenum almost immediately after it has crossed the mesial plane.*

At this stage it is useful to reflect upon the relations which exist between the abdominal and thoracic organs which lie upon the different aspects of the diaphragm. Braune has made these very clear by a number of dissections performed from above. We have seen that the right lobe of the liver occupies the right vault of the diaphragm, whilst the left lobe of the liver, the fundus of the stomach and the spleen occupy the left vault. The base of the right lung is in relation to the right lobe of the liver. The pericardium, in by far the greater part of its extent, lies

* A more extended account of the position and connections of the stomach will be found in Prof. Turner's "Introduction to Anatomy," from which the above description has been framed.

above the left lobe of the liver, which therefore intervenes between it and the stomach; only a limited portion of the apex of the heart extends over the region of the stomach. The base of the left lung lies over the left lobe of the liver, the fundus of the stomach and the spleen.

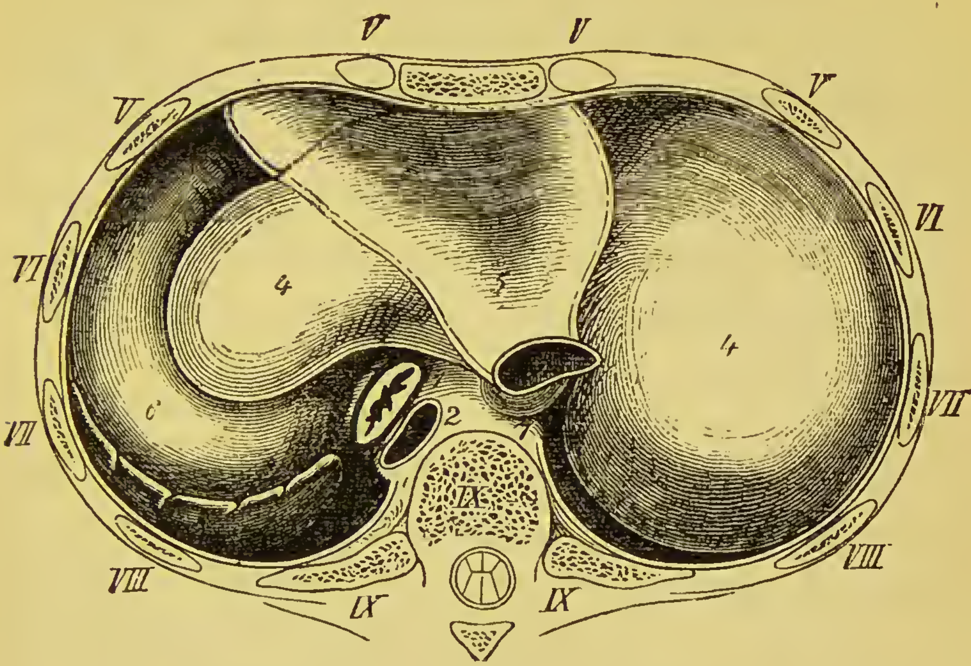


FIG. 20.

Position of viscera in relation to the under surface of the diaphragm. The dotted line marks off that part of the pericardium which lies directly above the stomach.—*From* BRAUNE'S *Atlas of Topographical Anatomy.*

(1) Œsophagus.
(2) Aorta.
(3) Vena cava.
(4) Liver.
(5) Pericardiac part of the diaphragm.
(6) Fundus of stomach.
(7) Lobulus Spigelii.
(8) Spleen.

The Small Intestine is that part of the alimentary canal which succeeds the stomach. It begins in the epigastric region at the pylorus, and ends in the right iliac fossa by joining the great intestine. Its average length is somewhere about twenty feet, and as it is traced towards its termination it will be seen to diminish slightly in calibre. It is divided into three portions, viz.:—

(1.) The duodenum.
(2.) The jejunum.
(3.) The ileum.

The duodenum is the name which is given to the first part of the small intestine. It equals in length the breadth of twelve fingers, and extends from the pylorus to the left side of the body of the second lumbar vertebra. As it lies deeply in the greater part of its extent, and as dissection is necessary to bring out its relations, it is better to defer its description till later on.

The jejunum and *ileum* constitute the coils of the small intestine. The jejunum begins where the duodenum ends—viz., on the left side of the body of the second lumbar vertebra; and the ileum ends, as we have seen, in the right iliac fossa by joining the cœcum or the commencement of the great intestine. The subdivision of the small intestine is of the most arbitrary kind. After mapping off the duodenum it is customary for anatomists to look upon the upper two-fifths of the remainder as being jejunum, and the lower three-fifths as being ileum. There is no hard-and-fast line of demarcation between the three divisions—the one passes insensibly into the other; and as the distinction is only to be found by an examination of the interior of the tube, it is impossible for the student at present to see any difference at all between them.

The coils formed by the jejunum and ileum are suspended from the posterior wall of the abdomen by a wide fold of peritoneum, called the mesentery. They are thus freely moveable within the cavity. They lie in the umbilical, hypogastric, and right and left iliac regions, and a few coils of ileum are always found extending downwards into the pelvis.

The Large Intestine.—The large intestine, although possessing a much wider calibre than the small intestine, is not nearly so long. It extends from the right iliac fossa, where we have seen it to be continuous with the ileum, to the anus, and it rarely measures more than five or six feet in length. Like the small intestine, it is widest at its commencement, and gradually diminishes in diameter as it advances towards its termination. A short way above the anus, however, it again expands. It is subdivided arbitrarily into the following parts :—

The cœcum.

The colon.
- Ascending colon.
- Hepatic flexure.
- Transverse colon.
- Splenic flexure.
- Descending colon.
- Sigmoid flexure.

The rectum.

The *cœcum* is the blind commencement of the large intestine. It lies in the right iliac fossa, and is connected with the surface of the fascia iliaca by some loose areolar tissue. Under ordinary circumstances it is clothed anteriorly and laterally by peritoneum, whilst its posterior aspect is bare. It is thus fixed in its position. In some few cases, however, the peritoneum may be found investing it completely, and connecting it with the iliac fossa by a distinct fold called the *meso-cœcum.* When this happens the cœcum enjoys a certain amount of movement, and may even form a part of the contents of a hernial sac. The ileum opens into it upon its inner aspect about two and a-half inches above its blind end, and marks the point where it becomes continuous with the ascending colon.

In connection with the cœcum the dissector will find the *vermiform appendix.* This is a narrow cœcal tube, which has a diameter slightly greater than that of a goose quill, and a length which varies from three to five or six inches. It opens into the cœcum upon its inner and back aspect below the termination of the ileum. It is held in position by a minute peritoneal fold, which constitutes its mesentery.

The *ascending colon* extends vertically upwards through the right lumbar region. It is continuous below with the cœcum, whilst above it becomes the hepatic flexure. Its relation to the peritoneum is similar to that of the cœcum; it is clothed anteriorly and laterally, whilst posteriorly it is bare and this bare surface rests upon the fascia covering the quadratus lumborum muscle, upon the right kidney and upon the second part of the duodenum, with each of which it is connected by a little loose areolar tissue. In rare cases the peritoneum may surround the tube and form behind it a very short meso-colon.

The *hepatic flexure* is the bend which connects the ascending colon with the transverse colon. It is situated in the right hypochondrium. When the colon reaches the concave inferior surface of the right lobe of the liver, it bends slightly forwards and then turns suddenly to the left, and this constitutes the flexure.

The *transverse colon*, continuous on the one hand with the hepatic flexure, and on the other with the splenic flexure, stretches across the abdominal cavity. At first it descends from the right hypochondrium into the umbilical region, and then ascends into the left hypochondrium. It takes an arched course, the summit of the arch being nearer the anterior wall of the abdomen, and at the same time at a lower level in the body, than its extremities. The transverse colon possesses greater freedom of movement than any other part of the great intestine. It is attached to the posterior abdominal wall by a wide peritoneal fold, called the *transverse meso-colon*.

The *splenic flexure* is the term applied to the bend which the colon takes in the left hypochondrium before proceeding downwards as the descending colon. It receives its name from the fact that it lies in intimate relation with the lower extremity of the spleen. A fold of the peritoneum with a free crescentic border binds it to the diaphragm opposite the tenth or eleventh rib. This fold is called the *phrenico-colic* or the *costo-colic ligament*.

Braune has pointed out that when the stomach is empty and the colon greatly distended with gas the splenic flexure may rise so high as to occupy a position against the vault of the diaphragm, beside the fundus of the stomach. In such a case it intervenes between the stomach and the thoracic wall, and would yield a tympanitic note upon percussion.

The *descending colon* takes a vertical course downwards through the left lumbar region, and, on gaining the left iliac region, becomes continuous with the sigmoid flexure. Its anterior surface and its sides are covered by peritoneum, but its posterior surface is bare, and rests upon the quadratus lumborum and the left kidney, to which it is connected by loose areolar tissue.

It is into the lower part of this division of the colon that the surgeon opens in the operation of Colotomy. The opening is made into the posterior aspect of the tube so as to avoid wounding the peritoneum. It is therefore essential that the posterior relations of the descending colon should be laid down with more than usual precision. Braune, by means of his sections of the frozen body, has rendered material help in this respect. At the level of the third lumbar vertebra, where the colon is in relation to the kidney, it lies along the outer border of the quadratus lumborum. Between the lower end of the kidney and the crest of the ilium (where the operation is performed) the quadratus lumborum is placed behind the colon, and must be divided, or pushed aside, in order to reach it. It may be noted that the outer edge of the erector spinæ usually corresponds with the bare posterior surface of the colon at this level.

The *sigmoid flexure* is a double bending of the colon like the letter S. It lies in the left iliac fossa, to which it is bound by a distinct *sigmoid meso-colon.* It is continuous above with the descending colon, whilst opposite the left sacro-iliac articulation it gives place to the rectum.

The *rectum* will be described with the pelvic viscera.

Adaptation of the Abdominal Walls to the Viscera, and of the Viscera to each other.—The abdomen is an air-tight cavity, and the atmospheric pressure acts upon its mobile walls so as to keep them constantly in accurate apposition with the viscera, and also the viscera in accurate contact with each other. During life and in the undissected subject no space of any kind is left vacant, and consequently some anatomists decline to apply the term "cavity" to the abdomen. The external configuration of the solid organs within the abdomen is, to a great extent, determined by this close adaptation of walls to contents, and viscus to viscus. The liver is the best example of this—almost every structure with which it is in contact leaves its mark upon it, in the form of a depression, whilst its upper surface presents an exact mould of the under surface of the diaphragm.

The Peritoneum.—The peritoneum is the serous membrane which lines the walls of the abdominal cavity, and gives more or less complete coverings to all the viscera within it. In the male it is a *closed sac* like other serous membranes. In the female, however, there is a small opening at the extremity of the Fallopian tube, by means of which the lumen of this tube communicates with the interior of the sac. It differs from other serous sacs in its great size, and also in its many complications. Take, for example, the pleura or the serous pericardium, or the tunica vaginalis; in these cases the serous membrane lines a cavity which holds a single viscus, and the reflection of the membrane from the walls on to the viscus, and from the viscus again on to the walls can be followed with the greatest ease. The peritoneal sac, on the other hand, belongs to a cavity which contains numerous viscera, some of which have undergone striking changes in position during development, and this is the reason why it is so very complicated.

In opening the cavity of the abdomen, the peritoneal sac has been laid open, and the inner surface of the membrane is observed to present the usual smooth, polished, and glistening appearance. The part which lines the walls of the abdomen is termed the *parietal peritoneum;* that which is reflected on to viscera is called the *visceral peritoneum.*

Before tracing the peritoneum through its many windings, it is well that some terms which are applied to certain of its folds should be explained. The term *omentum* is employed to denote a fold of peritoneum which connects the stomach with neighbouring viscera. Thus we have the *great* or *gastro-~~hepatic~~ omentum* connecting it with the transverse colon; the *small* or *gastro-hepatic omentum* connecting it with the liver; and the *gastro-splenic omentum* connecting it with the spleen. The term *mesentery* is applied to any fold of peritoneum which attaches the intestinal tube to the posterior wall of the abdomen, as, for example, the *mesentery proper* in connection with the small intestine, the *transverse meso-colon*, the *sigmoid meso-colon*, the *meso-rectum*, and the occasional *meso-cæcum.* The term *ligament* is given to folds which connect viscera which are not parts of the intestinal canal to the walls of the abdomen, or which bind viscera of any kind to the diaphragm. Examples of these are to be found in the ligaments of the liver, bladder, uterus, also in the *phrenico-splenic* ligament, the *phrenico-colic* ligament, and the *gastro-phrenic* ligament.

Let us now endeavour to follow the peritoneal membrane in the vertical direction. The best point to start from is the *great omentum*, or the large fold which is spread out upon the surface of the small intestines. The great omentum is composed of *four* layers—*two anterior* and *two posterior* layers, and these are continuous with each other at the lower free margin of the fold. Trace the *two anterior* layers upwards. They lead us to the greater curvature of the stomach, and here they separate from each other so as to enclose this viscus between them—one passing in front and the other behind it. The smooth glistening appearance presented by the surface of the stomach is due to the peritoneal coating which it thus acquires. At the lesser curvature of the stomach the two layers come together, and are prolonged upwards to the liver as a distinct fold, which receives the name of the *gastro-hepatic* or *lesser omentum.* Reaching the transverse fissure of the liver, the two layers again separate, this time to enclose the liver. The one layer is directed forwards over the under surface of the organ, round its anterior border, and then backwards over its superior surface. On reaching the point where the

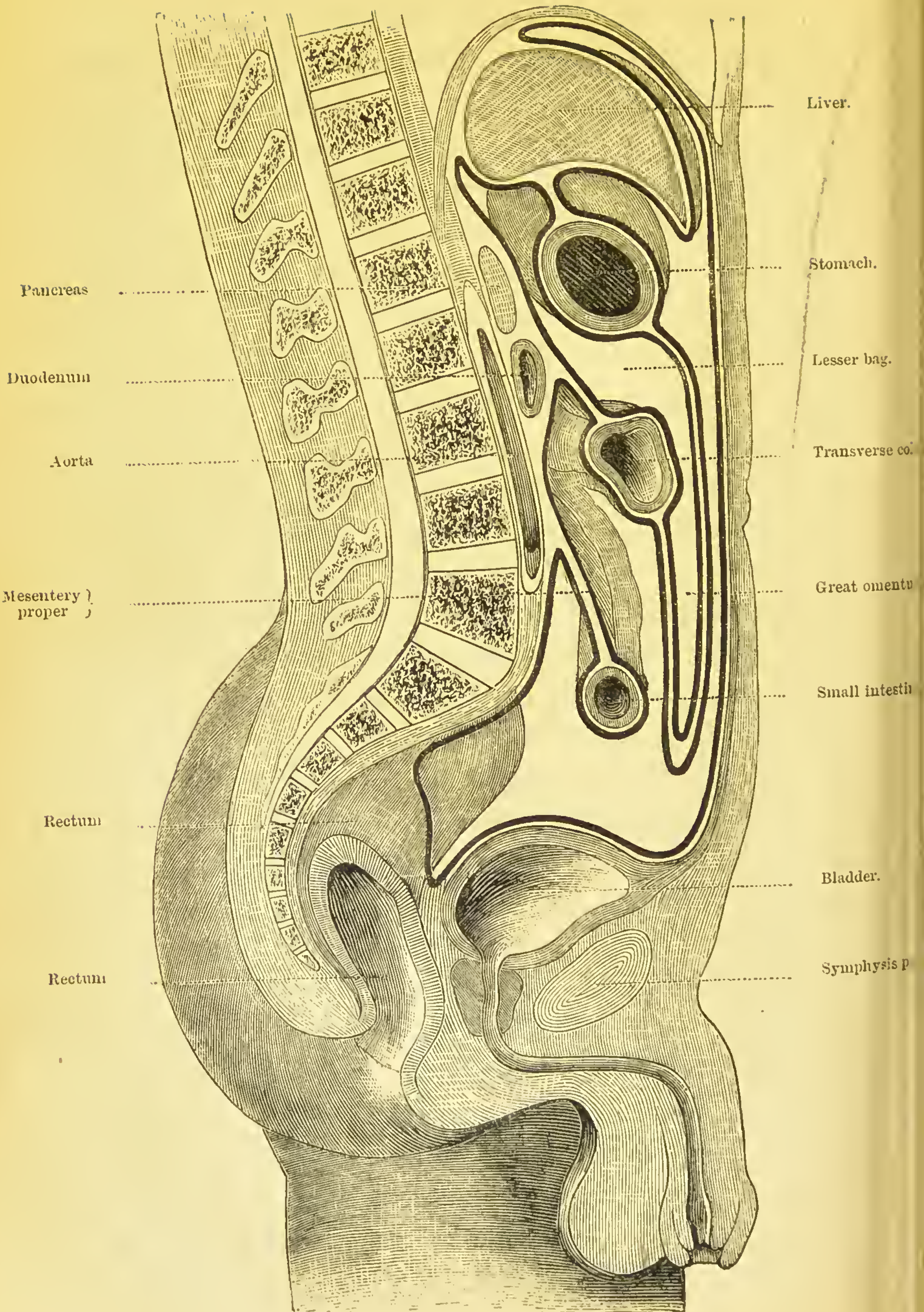


FIG. 21.
Diagram of the peritoneum—vertical section through a male subject.

liver and diaphragm are in contact, it is reflected on to the diaphragm and proceeds forwards upon its under surface to reach the anterior wall of the abdomen. The other layer turns backwards upon the under surface of the liver, and reaching its posterior border is reflected on to the back part of the diaphragm, and turns downwards on the posterior wall of the abdomen. We will leave these layers for a little and trace the *two posterior* layers of the omentum. For this purpose it is necessary to turn up the great omentum over the ribs. Its two posterior layers in proceeding upwards come to the transverse colon. This they enclose, the one passing in front and the other behind, and coming in contact with each other again on the other side of the gut, they are prolonged backwards to the posterior wall of the abdomen, as the *transverse meso-colon.* They reach the back wall of the abdomen at the point where the transverse or third part of the duodenum extends to the left, across the spine, and here they separate. The one layer passes above this part of the duodenum, and then turns upwards over the pancreas to become continuous with the layer which we left upon the posterior wall of the abdomen. The other layer gains the spine below the third part of the duodenum, and is almost immediately led off the posterior wall of the abdomen by the superior mesenteric vessels, which conduct it to the small intestine. Turning round the gut so as to invest it, it proceeds backwards upon the posterior aspect of the superior mesenteric vessels to the spine. In this manner the *mesentery proper* is formed. It is now carried downwards over the posterior abdominal wall into the pelvis, where it may be traced over the rectum and bladder,* to both of which it gives partial coverings, and then on to the anterior abdominal wall, where it becomes continuous with the layer which we left here.

The *two anterior* layers of the great omentum therefore proceed upwards to the under surface of the diaphragm, and there separate, the one passing forwards over the anterior portion of its under surface to reach the anterior wall of the abdomen, whilst the other is directed backwards over the posterior part of its under surface to reach the posterior wall of the abdomen. On their way up to the diaphragm these layers enclose the stomach, form the gastro-hepatic omentum, and partially enclose the liver. On the other hand, the *two posterior* layers are directed backwards to the spine, and there separate. In passing back they enclose the transverse colon, form the transverse meso-colon, whilst at the spine the third part of the duodenum lies between them. The one layer ascends to become continuous with the layer on the posterior abdominal wall. The other layer passes downwards, forms the mesentery proper, enters the pelvis, and then reaches the anterior abdominal wall.

A reference to Fig. 21 will show that the peritoneal sac is arranged in two pouches, a *large pouch* in front and a *smaller pouch* situated behind it. The large

* In the female it also gives a covering to the uterus, but the disposition of the peritoneum in the pelvis, both male and female, will be fully described in connection with the pelvic viscera.

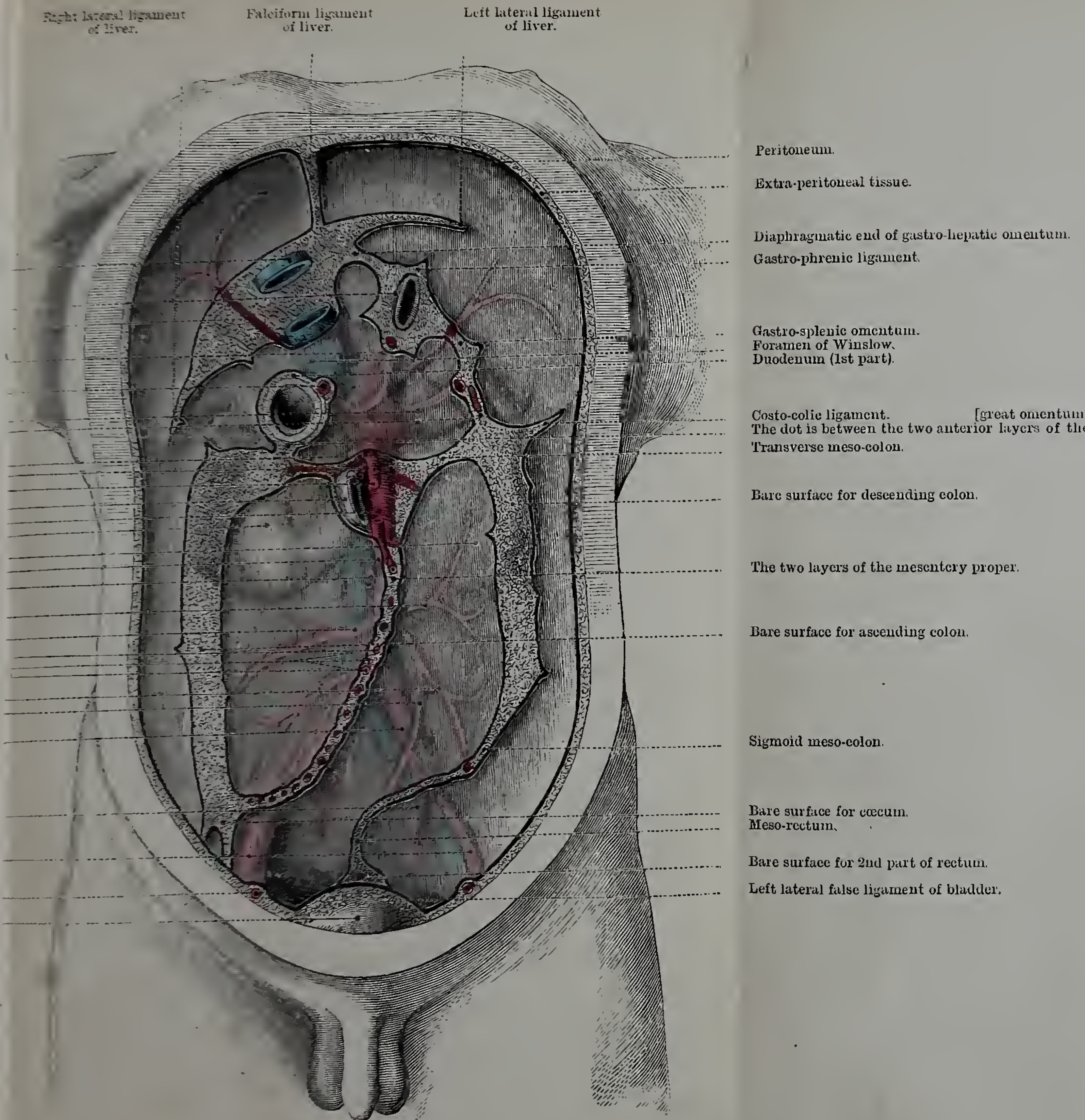


PLATE IV.

Diagram devised by Mr. Sheridan Delépine to show the lines along which the peritoneum leaves the wall of the abdomen to invest the viscera.

pouch is the one into which we have opened in opening the cavity of the abdomen. Now it must be clearly understood that these are simply compartments of *one* serous sac, and that they communicate freely with each other through a narrow channel, called the **Foramen of Winslow.** To find this foramen, the hand must be thrust deeply into the right hypochondrium and the forefinger pushed inwards and to the left along the under surface of the liver and behind the right free margin of the gastro-hepatic omentum. It will slip through the foramen of Winslow into the lesser peritoneal sac.*

The *foramen of Winslow* has the following boundaries :—*in front*, the right free margin of the gastro-hepatic omentum, between the two layers of which are the hepatic artery, the portal vein, the hepatic duct, and some nerves ; *behind*, the vena cava, and the right crus of the diaphragm, covered by the layer of the transverse meso-colon, which passes upwards on the posterior wall of the abdomen ; *below*, the duodenum ; and *above*, the lobulus Spigelii of the liver at its junction with the lobulus caudatus.

The lesser bag of the peritoneum may be looked upon as a portion of the greater bag invaginated or thrust over towards the left side of the abdominal cavity behind the hepatic vessels. It extends *downwards* to the lower free border of the omentum, *upwards* to the under surface of the Spigelian lobe of the

* A good way to find the foramen of Winslow is to lay hold of the fundus of the gall-bladder with the left hand, and then pass the forefinger of the right hand backwards along it towards its duct. The finger will slip behind the gastro-hepatic omentum into the foramen.

liver and back part of the diaphragm, and *to the left* as far as the spleen. It is closed in the following manner:—*in front*, by the two anterior layers of the great omentum, by the stomach, and by the gastro-hepatic omentum; *behind*, by the two posterior layers of the great omentum, by the transverse colon, by the transverse meso-colon, and by the layer which ascends on the posterior wall of the abdomen over the pancreas; on *the left side*, by the spleen and gastro-splenic omentum.

In a favourable subject these points can be made out by dividing the two anterior layers of the great omentum along the greater curvature of the stomach, and introducing the hand into the lesser sac. The entire extent of the pouch can thus be explored and its continuity with the greater bag demonstrated by turning the forefinger to the right and bringing it out through the foramen of Winslow, or by passing the forefinger of the other hand into the foramen of Winslow and making the two fingers meet behind the gastro-hepatic omentum.

The peritoneal lining of the abdomen must also be traced in the transverse direction at different levels. Fig. 21 gives a diagrammatic view of the manner in which it is arranged at the level of the foramen of Winslow or the twelfth dorsal vertebra. Taking the gastro-hepatic omentum as the starting-point, follow the two layers of which this is composed to the right. They become continuous around the hepatic artery and duct and the portal vein forming the right free border of this omentum and the anterior boundary of the foramen of Winslow. Following them to the left, they separate to enclose the stomach, and then, coming in contact again, they are prolonged to the spleen in the form of the *gastro-splenic omentum.* Here they separate again, and the posterior of the two layers is reflected backwards to the posterior abdominal wall,

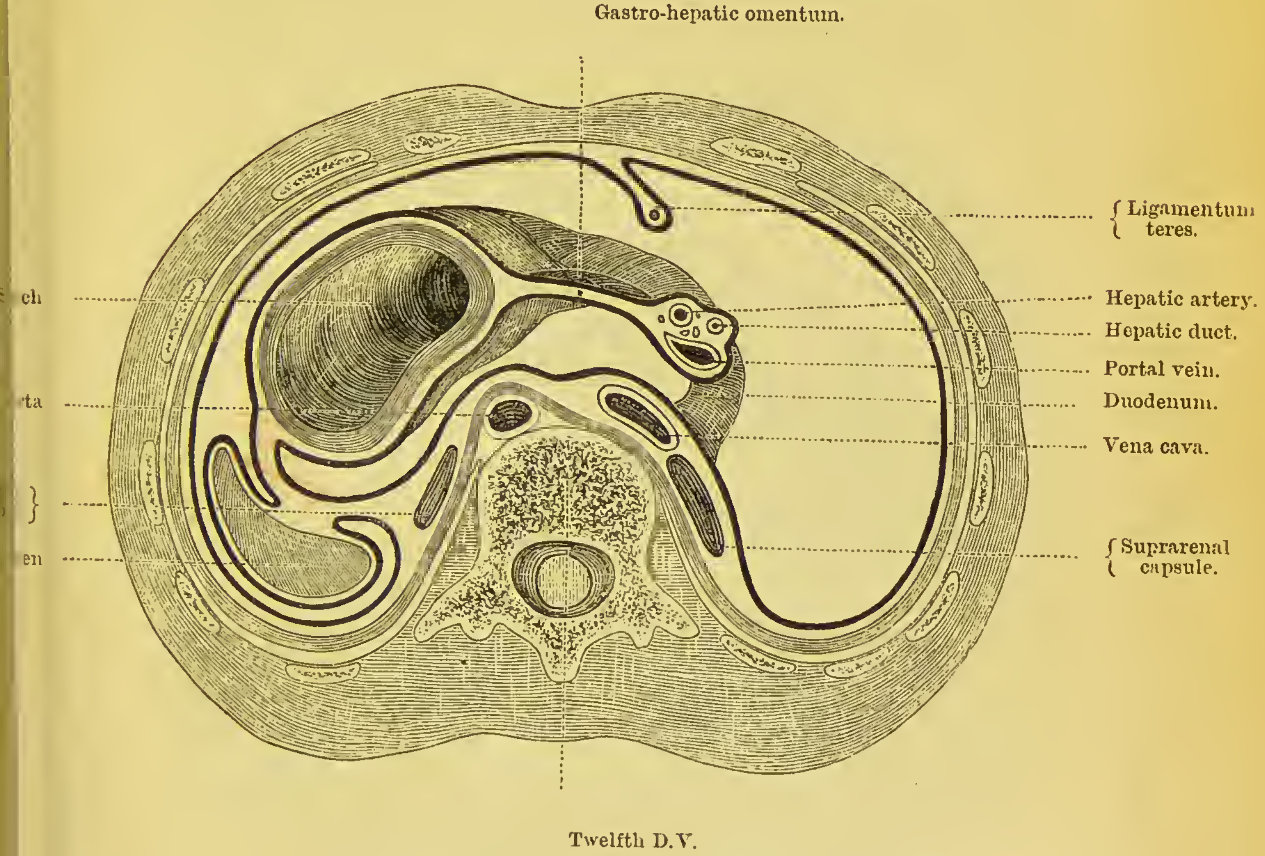


FIG. 22.

Section through the peritoneal cavity at the level of the foramen of Winslow. The dotted line pointing out the duodenum is directed through the foramen into the lesser bag.

upon which it turns to the right. It passes over the left suprarenal capsule, giving it a partial covering, over the vena cava where it bounds the foramen of Winslow posteriorly, over the right suprarenal capsule, and then on to the lateral and anterior walls of the abdomen. The anterior layer which we left at the spleen turns round this organ so as to give it its serous covering, and, reaching again its inner aspect, it is reflected back upon the posterior wall of the abdomen, and is carried to the left over the lateral and anterior wall of the abdomen, where it becomes continuous with the layer which we left there. Observe that at this level the peritoneum is borne off the anterior wall of the

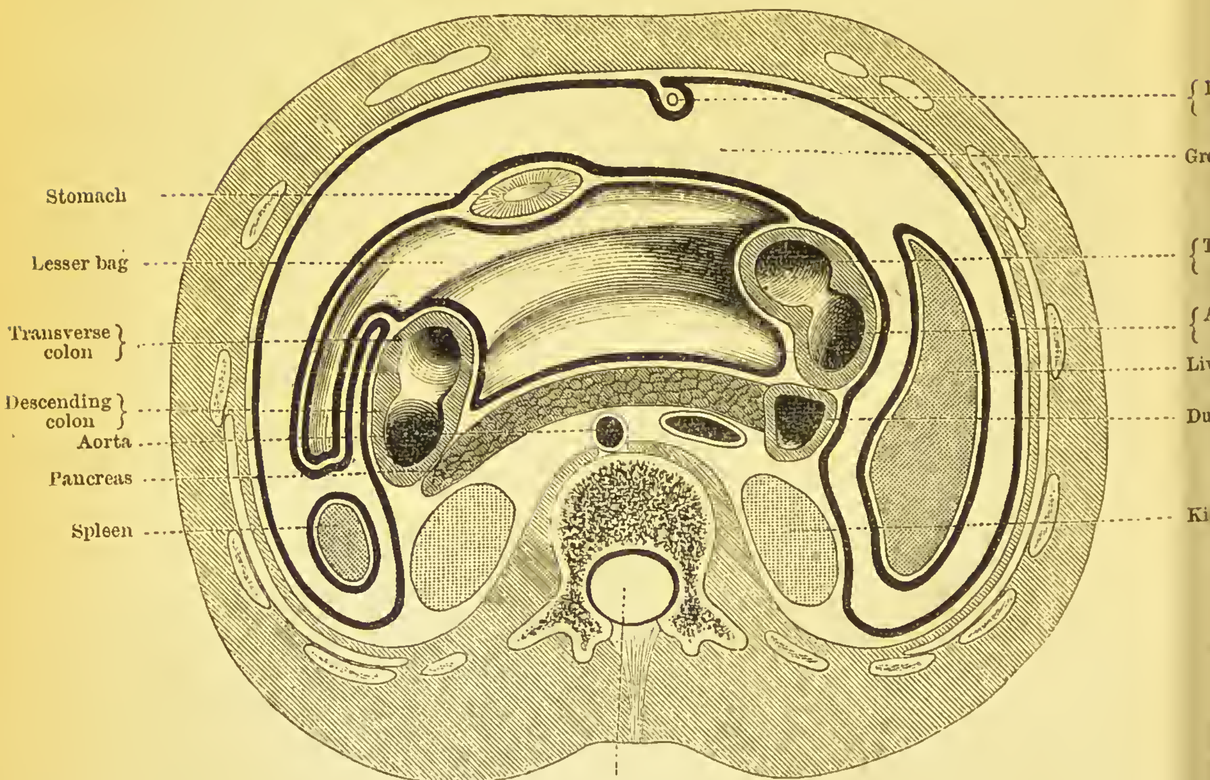


FIG. 23.*

abdomen by the obliterated umbilical vein, so as to form a distinct fold called the *falciform ligament* of the liver.

The disposition of the peritoneum at the level of the first lumbar vertebra is brought out in Fig. 23. This diagram explains itself. It will be noticed that the

* This diagram was devised by Mr. Sheridan Delépine, student of medicine.

viscera are drawn out of proportion to the size of the abdominal cavity in order that the windings of the peritoneal membrane may the more easily be followed. The upper or anterior surface of the transverse meso-colon is displayed, and its ascending layer, as it passes upwards over the pancreas, is seen in section. The two

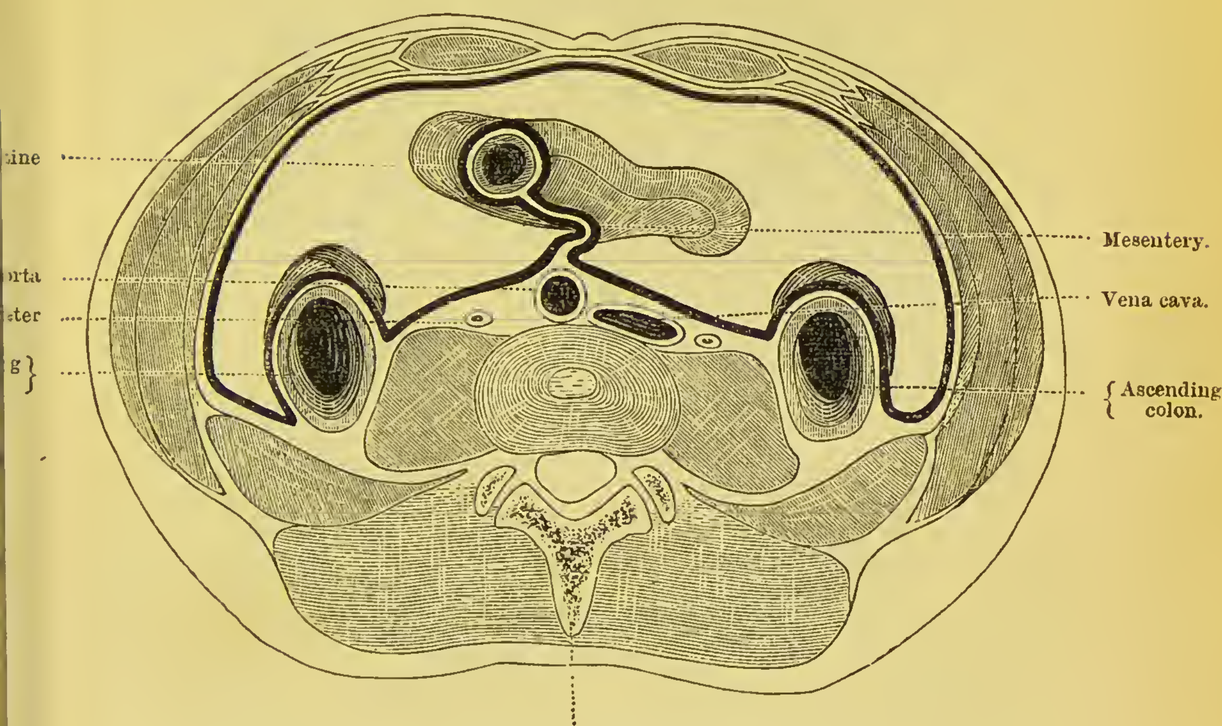


FIG. 24.

Section at the level of the umbilicus through the intervertebral disc between the third and fourth lumbar vertebræ.

anterior layers of the great omentum are represented at the point where they reach the greater curvature of the stomach—a small portion of which may be observed between them.

Opposite the umbilicus, at the level of the inter-vertebral disc between the third and fourth lumbar vertebræ, the peritoneum may be followed in the transverse direction with the greatest ease (Fig. 19). Take the *mesentery proper* as the starting-point, and trace its two layers towards the small intestine. They will be observed to be continuous around it. Now

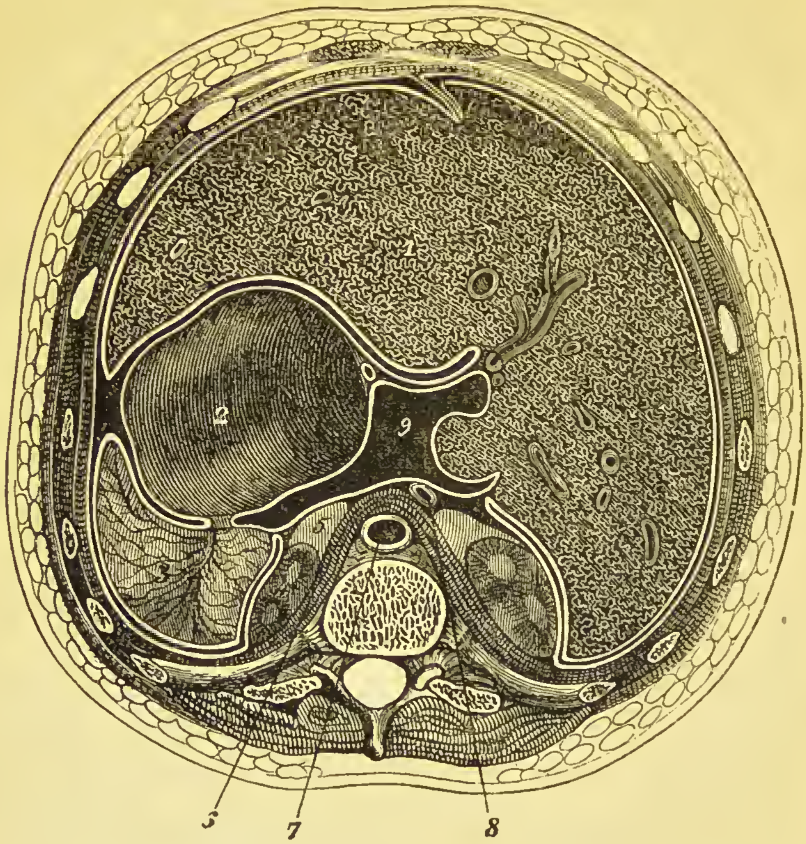


FIG. 25.

Section through the abdominal cavity at the upper border of the 12th dorsal vertebra, above the level of the foramen of Winslow. From this it will be seen that the lobulus Spigelii is the only part of the under surface of the liver which is clothed by the lesser sac.—*From* LUSCHKA'S *Anatomy.*

(1) Liver.
(2) Stomach.
(3) Spleen.
(4) Kidney.
(5) Suprarenal capsule.
(6) Diaphragm.
(7) Aorta.
(8) Vena cava.
(9) Lesser bag of peritoneum.

follow them backwards to the spine, and here they will be observed to separate—the one turning to the right, and the other to the left over the posterior wall of the abdomen. In the lumbar regions they meet the ascending and descending portions of the colon. These they clothe anteriorly and laterally, as we have already seen, and then they are carried on to the anterior wall of the abdomen, where they become continuous.

Peritoneal Ligaments.—In the abdomen proper, the student must specially examine—(1.) the *gastro-phrenic* ligament; (2.) the *phrenico-splenic* ligament; (3.) the *phrenico-colic* ligament; and (4.) the *hepatic* ligaments.

The *gastro-phrenic ligament* is a fold which connects the fundus of the stomach with the under surface of the diaphragm. It is placed close to the œsophageal opening, on its left side, and is formed entirely by that layer which ascends over the anterior surface of the fundus of the stomach to reach the diaphragm. It is simply a reduplication or exaggerated wrinkle of this layer.

It is interesting to note that the stomach is not completely covered by peritoneum. There is a small area of a somewhat triangular form situated on its posterior surface immediately below the œsophagus, which is bare, and rests directly upon the left crus of the diaphragm.*

The *phrenico-splenic*, and the *phrenico-colic* ligaments have been already noticed.

The *ligaments of the liver* are *five* in number—viz., (1.) the ligamentum teres; (2.) the falciform ligament; (3.) the coronary ligament; (4.) the right lateral, and (5.) the left lateral ligaments.

The *ligamentum teres* is not a peritoneal ligament,

* This was proved by C. W. Cathcart, F.R.C.S., Demonstrator of Anatomy in this University, while working in Leipzig under the direction of Professor Braune.

but it is convenient to describe it with the others. It is a fibrous cord, in fact the obliterated umbilical vein, which extends from the umbilicus upwards, backwards, and to the right, to the anterior part of the longitudinal fissure on the under surface of the liver.

The *falciform ligament*, also called the *broad* or the *suspensory* ligament, is a double layer of peritoneum of a triangular shape. By its *anterior border* it is attached to the anterior wall of the abdomen, and to the under surface of the diaphragm, whilst by its *posterior border* it is fixed to the upper surface of the liver so as to mark it off into a right and left lobe. Its *lower border* or *base* is free, and contains between its two peritoneal layers the ligamentum teres. At its *apex*, which is directed backwards, the two layers of peritoneum diverge from each other—the one passing to the right, and the other to the left, so as to form the upper layer of the coronary ligament.

The coronary ligament.—To understand this ligament aright it must be borne in mind that an irregular area on the posterior border of the liver is devoid of peritoneum, and that this area is in direct apposition with the diaphragm, to which it is connected by some loose areolar tissue. The peritoneum covering the upper surface of the liver is reflected at the upper limit of this bare area directly on to the diaphragm; this reflection constitutes the *upper layer* of the coronary ligament. The *lower layer* of the ligament is formed at the lower limit of the bare area by the reflection of the peritoneum from the under surface of the liver on to the diaphragm. The two layers, therefore, of the coronary ligament are not in contact with each other, but are separated by a distance equal to the breadth of the bare surface of the liver.

The lateral ligaments.—At the right and left extremities of the bare area of the liver the two layers of the coronary ligament come into apposition with

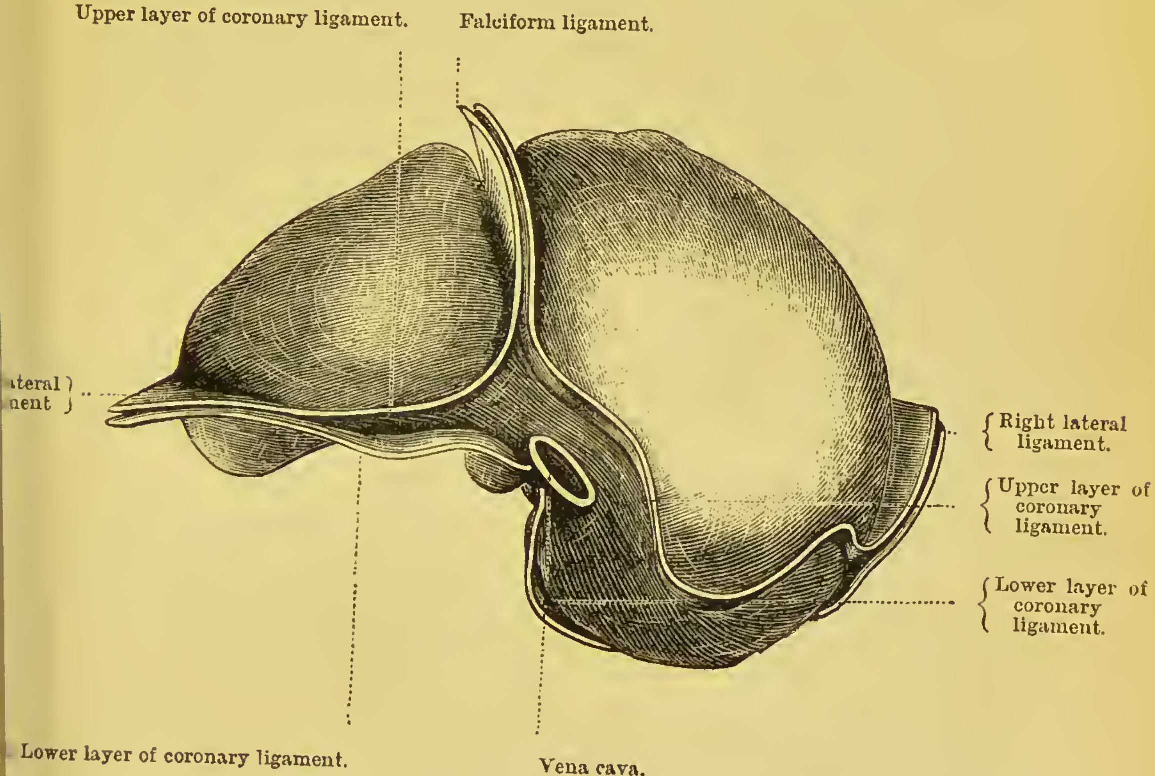


FIG. 26.

Superior surface and posterior border of liver to show bare area and the attachments of the ligaments.

each other, and constitute two distinct folds of peritoneum, which connect the liver to the diaphragm. These are the *right* and *left* lateral ligaments. With regard to the left ligament it should be noted that it does not spring from the posterior border of the left lobe of the liver, but from the superior surface a little anterior to this.

The Mesentery Proper.—Throw the great omentum and transverse colon upwards over the ribs and examine the mesentery proper. It will be found to be attached to the posterior wall of the abdomen along an oblique line which extends from the left side of the body of the second lumbar vertebra, downwards and to the right, into the right iliac fossa. This attachment is termed the *root* of the mesentery, and is comparatively narrow, but as the mesentery approaches the coils of the jejunum and ileum it widens out enormously, so that when it reaches the gut its width equals the length of these two portions of the small intestine. This great width is not apparent, because the mesentery is wrinkled, or thrown into folds like a goffered frill. The coiled condition of the gut is due to this arrangement.

The two layers of the mesentery are not in direct apposition with each other. They are separated by certain structures which lie between them, viz.—

(1.) The superior mesenteric vessels.
(2.) The superior mesenteric nerves.
(3.) Great numbers of lymphatic glands and lacteal vessels.

These must now be dissected. Remove the anterior layer from the root of the mesentery down to where it is attached to the gut. Begin at the upper end of the jejunum at the left side of the second lumbar vertebra, and gradually travel downwards to the lower end of the ileum, stripping off the peritoneum and cleaning the structures exposed. To display all the branches of the superior mesenteric artery it is necessary to remove also the inferior layer of the transverse meso-colon and the peritoneum which proceeds on the posterior wall of the abdomen towards the cœcum and ascending colon. Follow the main trunk of the artery upwards to its origin from the aorta, by raising the lower border of the pancreas.

Superior Mesenteric Artery. — The superior mesenteric artery springs from the front of the abdominal aorta about a quarter of an inch below the cœliac axis. At its origin it is covered by the pancreas, and crossed by the splenic vein. Emerging from under cover of the pancreas, it crosses the transverse part of the duodenum, near where it becomes the jejunum, and the left renal vein, and then enters the mesentery proper. Between the two layers of the mesentery it takes a slightly curved course towards the right iliac fossa, where it ends by anastomosing with one of its own branches. The convexity of the curve which it describes is directed to the left, and the concavity to the right. It is accompanied by the superior mesenteric vein, which lies upon its right side, and by the superior mesenteric plexus of nerves which surrounds it closely.

The following branches proceed from the superior mesenteric artery :—

(1.) Inferior pancreatico-duodenal.

(2.) Branches to the jejunum and ileum.	Rami intestini tenuis.
(3.) Branches to the great intestine.	Ileo-colic. Right colic. Middle colic.

The *inferior pancreatico-duodenal* takes origin from the superior mesenteric under cover of the pancreas. It has a curved course round the head of this gland, between it and the duodenum, and gives branches to both. It ends by anastomosing with the superior pancreatico-duodenal artery.

The *rami intestini tenuis* spring from the convexity of the superior mesenteric, and proceed obliquely downwards and to the left, between the layers of the mesentery, to supply the jejunum and ileum. They are very numerous (from fifteen to twenty in number), and, by their mutual inosculations, they form a very remarkable series of arches before they finally reach the bowel. At first they run parallel to one another, but soon they divide into two branches, each of which joins its neighbour, and in this way a succession of arterial arcades is formed. From these smaller twigs proceed, which divide and unite in a similar manner to form a second series of arches, and so on, until three, four, or perhaps even five tiers of arterial arcades are produced. From the lowest arches a multitude of minute twigs pass directly to the wall of the intestine.

The *colic branches* spring from the concavity of the superior mesenteric artery.

The *ileo-colic artery*, the lowest of the three branches which go to the great intestine, proceeds downwards, between the two layers of the mesentery, towards the right iliac fossa, and divides into a descending and an ascending branch. The *descending* branch joins the

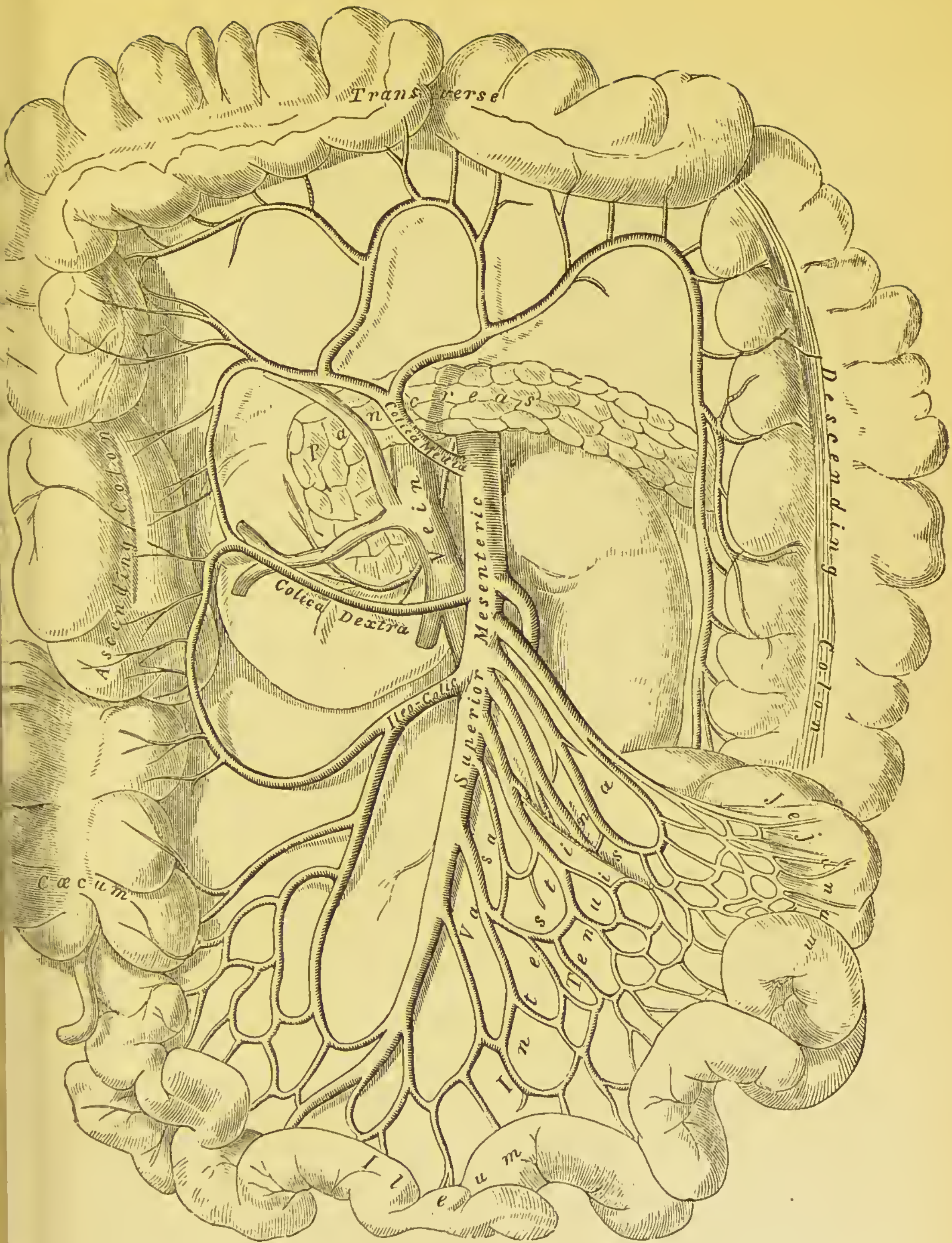


FIG. 27.

Diagram of the superior mesenteric artery and its branches
—*From* GRAY'S *Anatomy.*

terminal part of the superior mesenteric, and from the arch thus formed twigs are given to the lower end of the ileum, the vermiform appendix, and the cœcum. The *ascending* branch inosculates with a branch of the right colic, and sends offsets to the ascending colon.

The *right colic artery* very frequently arises in common with the ileo-colic. It takes a horizontal course to the right, and divides into two branches, a superior and an inferior. The *superior* branch ascends between the two layers of the transverse meso-colon to inosculate with the middle colic; whilst the *inferior* branch joins the ascending part of the ileo-colic. From the convexity of these arches twigs proceed to the colon.

The *middle colic artery* is the highest of the three branches which spring from the concavity of the superior mesenteric. It ascends between the two layers of the transverse meso-colon, and divides into a right and a left branch. The *right* branch joins the superior part of the right colic, whilst the *left* branch inosculates with the ascending part of the *left colic artery*, which is derived from the inferior mesenteric.

The Superior Mesenteric Vein lies to the right of the artery and receives tributaries, which come from those parts of the intestinal canal which are supplied by branches from the superior mesenteric artery. Leaving the mesentery, it passes upwards in front of the duodenum, and then disappears under cover of the pancreas. Here it unites with the splenic vein to form the *vena portæ*.

The Superior Mesenteric Nervous Plexus is a dense plexus of sympathetic twigs, which surrounds the superior mesenteric artery like a sheath. From it filaments are prolonged to the gut along the various branches of the artery. As the nerves approach the bowel, some of the twigs leave the vessels and effect a series of communications with each other in the intervals between the arteries.

The superior mesenteric plexus is an offshoot from the *solar plexus*, and it distributes twigs to the jejunum, ileum, and to the right half of the great intestine.

Mesenteric Lymphatic Glands.—These are very numerous, indeed considerably over a hundred in number. In health they rarely attain a size greater than that of a bean or a pea, and they are scattered irregularly between the two layers of the mesentery in the intervals between the blood-vessels. It should be noted, however, that they are most numerous opposite the jejunum, and that the mesentery in immediate relation to the gut is free from them. The lacteals on emerging from these glands converge and unite into two or three large vessels, which lie alongside the superior mesenteric artery, and finally end in the receptaculum chyli.

A few lymphatic glands will also be noticed in connection with the great intestine.

Inferior Mesenteric Artery.—The coils of the small intestine must now be pulled over to the right side of the body, and the peritoneum carefully removed by the fingers from the lower part of the aorta and the left side of the spine and psoas muscle. The inferior mesenteric artery is thus exposed, and its branches can be followed to their distribution. The *ureter* and the *inferior mesenteric* vein will be seen lying upon the psoas.

The *inferior mesenteric artery*, considerably smaller than the superior mesenteric, springs from the left side of the abdominal aorta, about an inch and a-half above its bifurcation into the two common iliacs, and descends with a slight inclination to the left, towards the left iliac fossa. At first it is applied to the left side of the aorta, to which it is bound by peritoneum; it then crosses the left common iliac artery and enters the pelvis, where it receives the name of *superior hæmorrhoidal.* Before leaving the abdomen proper it gives off two branches—viz., the left colic and the sigmoid.

The *left colic artery* proceeds to the left, over the left kidney, and divides into two branches, of which one ascends to inosculate with the middle colic, whilst the other descends to unite with the sigmoid. From the arches thus formed twigs are supplied to the colon.

The *sigmoid artery* runs almost horizontally across the psoas muscle to the left iliac fossa, where it breaks up into branches for the supply of the sigmoid flexure. It inosculates above with the left colic, and below with the superior hæmorrhoidal. In place of one, there are frequently several sigmoid arteries.

The *superior hæmorrhoidal artery* will be followed out in the dissection of the pelvis.

The Inferior Mesenteric Vein receives tributaries corresponding with the branches of the inferior

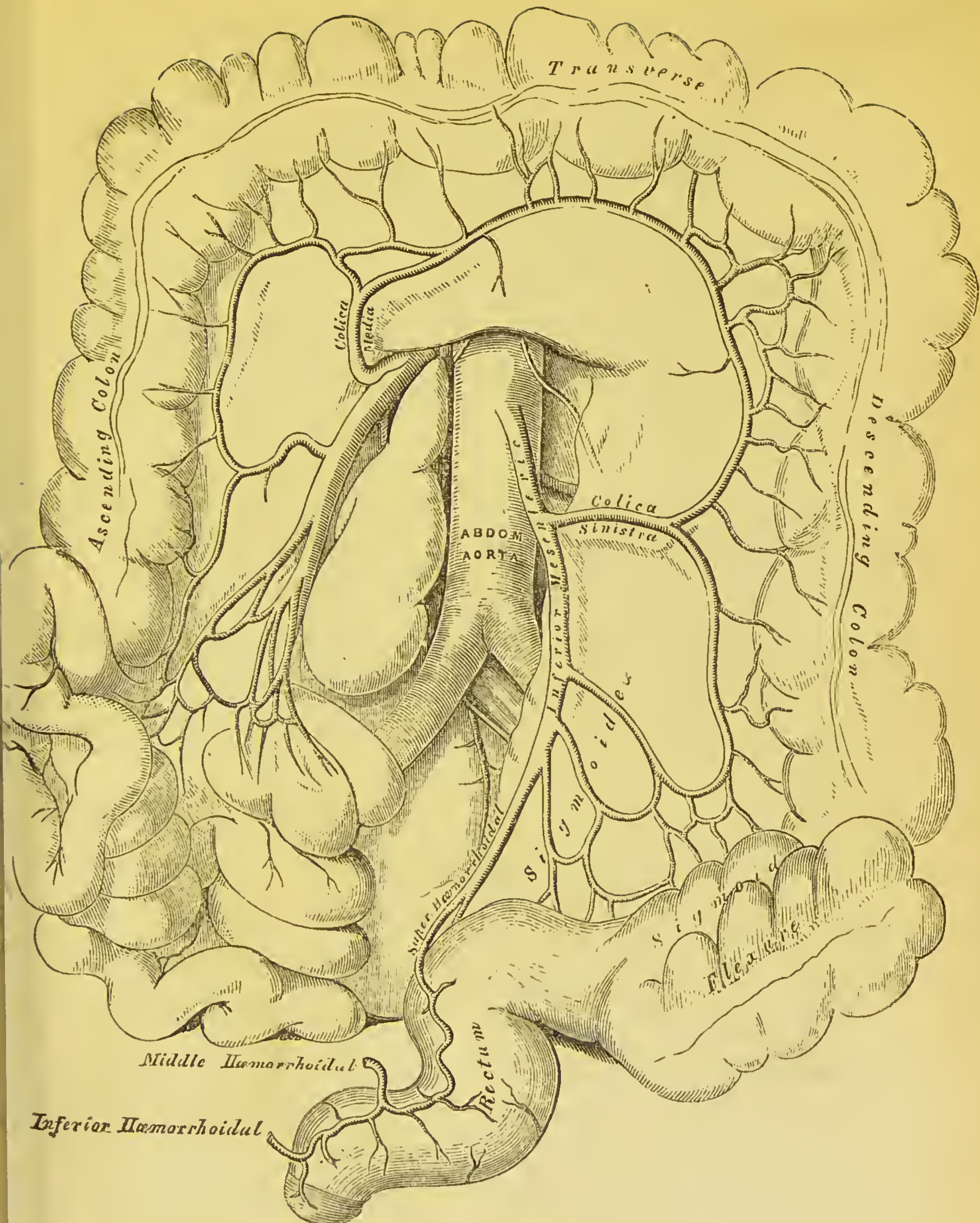


FIG. 28.

Diagram of the inferior mesenteric artery and its branches.
—*From* GRAY'S *Anatomy.*

mesenteric artery. It passes upwards upon the psoas muscle under cover of the peritoneum, to the left of, and at some distance from the artery, and, disappearing behind the pancreas, it ends in the splenic vein.

The Inferior Mesenteric Plexus of Nerves is an offshoot from the left side of the aortic plexus. It closely surrounds the artery, and sends twigs along the branches of the vessel to supply the left half of the great intestine.

Aortic Nervous Plexus.—If the peritoneum has been carefully stripped off the lower part of the aorta, there will be little difficulty in recognising and following out the delicate nerves which form this plexus. Raise the third part of the duodenum from the surface of the aorta, and trace these nervous twigs upwards.

The aortic plexus of nerves is placed upon the aorta between the origins of the two mesenteric arteries. It is more strongly marked upon the sides of the artery than in front of it. Superiorly it will be found to be continuous with the solar and renal plexuses, whilst inferiorly it sends numerous large branches downwards in front of the common iliac arteries to join the hypogastric plexus—a plexus which is situated in front of the upper part of the sacrum, and which will be afterwards dissected. Upon each side the aortic plexus will be observed to be reinforced by several small twigs from the gangliated cord of the sympathetic. We have already seen the *inferior mesenteric plexus* taking origin from it; it also gives off the *spermatic* (or *ovarian) plexus* of nerves which accompanies the spermatic artery.

Removal of the Intestines.—The jejunum, ileum, cœcum, and colon may now be removed from the abdominal cavity. Apply two ligatures around the upper end of the jejunum, about an inch or so to the left of the point where the superior mesenteric artery crosses the duodenum, and divide the gut between them ; then place two ligatures around the great intestine at the junction of the sigmoid flexure and the rectum, and divide it in like manner. The entire intestinal canal, with the exception of the duodenum and rectum, can now be taken away by carefully severing the blood-vessels and peritoneal folds which hold it in position. In cutting through the two layers of the great omentum which extend from the transverse colon to the stomach, keep the knife close to the gut so as to avoid injury to the vessels in relation to the greater curvature of the stomach.

As soon as the intestines are detached they should be taken to the sink and the ligatures removed. The small intestine should be separated from the great intestine by dividing the ileum about six inches from the point where it enters the cœcum, and, the remains of the mesentery having been taken away from the small intestine by means of the scissors, both should be thoroughly cleaned out by allowing the water from the tap to run freely through them.

Coats of the Small Intestine.—A small portion of the jejunum should now be opened up and stretched tightly upon a block by means of pins, with its mucous surface downwards, in order that its coats may be dissected. The jejunum is chosen because its wall is thicker than the ileum, and consequently the dissection is easier. The small intestine has five coats or strata entering into the formation of its walls, viz.:—

(1.) Serous.
(2.) Subserous.
(3.) Muscular.
(4.) Submucous.
(5.) Mucous.

The *serous coating* of the jejunum and ileum is complete, except along the line of the mesenteric attachment. It is exceedingly thin—much thinner than the layers of the mesentery, with which it is continuous. Unless great care be taken in stripping it off, some of the subjacent muscular fibres will be taken away with it. The *subserous coat* is a scarcely appreciable amount of areolar tissue which intervenes between the peritoneum and the muscular coat. The *muscular coat* is composed of involuntary non-striated muscular fibres. These are disposed in two layers—viz., an *external* stratum of longitudinal fibres, and an *internal* stratum of circular fibres. Of these the circular layer is the thicker and more distinct of the two. The *submucous coat* is composed of loose areolar tissue which binds the muscular to the mucous coat. It is more firmly connected with the latter. The *mucous coat* must be examined throughout the whole length of the jejunum and ileum.

The Mucous Membrane of the Small Intestine.

—The student has noticed that externally no distinction can be drawn between the jejunum and ileum, with this one exception—viz., that as the tube descends it diminishes slightly in its calibre and in the thickness of its walls. It is necessary, therefore, that he should open it up, with the view of determining what differences exist internally. The best way to do this is to tie a ligature around the lower cut end of the ileum, and fill the gut as full as possible with water. The scissors can now be easily carried along the *line of the mesenteric attachment*, and the intestine slit open in its entire length.*

The *valvulæ conniventes* are the most conspicuous objects on the inner wall of the small intestine. These are crescentic folds of the mucous membrane placed transversely to the long axis of the gut, and extending from one-third to two-thirds of the distance around the tube. Note particularly that they are *permanent folds*, and that no amount of stretching or distension of the walls will cause their obliteration. In the upper part of the jejunum the valvulæ conniventes are strongly developed, and placed so closely together that the intervals between them are hardly greater than the thickness of one of the folds. As we follow them down, however, they gradually diminish in numbers, become more widely separated and not nearly so prominent. Approaching the middle of the ileum, they become exceedingly sparse and

* Prof. Cleland, in his "Directory to the Dissection of the Human Body," makes a useful suggestion. He points out that the intestine can be laid open with much greater ease if a piece of costal cartilage be empaled upon that blade of the scissors which is introduced into the gut.

far between, and a little beyond this they disappear altogether.

The chief function of these valvulæ conniventes is to increase the absorbing and secreting surface of the small intestine. It is also probable that they prevent the too rapid passage of the aliment along the tube, and that they break the flow so as to mix up the contents of the small intestine with the intestinal juices and other secretions poured into the canal.

Another peculiarity characteristic of the mucous lining of the small intestine is the presence of *villi*. These are minute processes of the mucous membrane, varying in length fron one-fourth to one-third of a line. They occur in enormous numbers over the entire extent of the inner surface of the gut, not only upon the valvulæ conniventes, but also in the intervals between them, and they give to the mucous membrane a velvety or fleecy appearance.

To obtain a proper view of these minute villous processes it is necessary to float out a portion of the small intestine in water after it has been carefully cleansed from adhering mucus, and examine it with an ordinary pocket lens. If a portion of the upper end of the jejunum be placed side by side with a portion of the lower part of the ileum, and inspected in this manner, the student will readily detect that the villi are, if anything, larger, and that they are decidedly more numerous in the jejunum than in the ileum. They diminish gradually in number and in size as we pass down the small intestine.

Peyer's patches and the *solitary glands* must also be looked for. Frequently they are difficult to find, but by holding the bowel up to the light they can generally be detected. In our examination of Peyer's patches it is better to begin at the lower end of the ileum and pass upwards.

A *Peyer's patch* consists of a large number of lymphoid follicles grouped together so as to present to the eye a patch of an elongated, oblong figure. The long axis of the patches corresponds in its direction with that of the gut itself, and they are always placed upon that aspect of the wall of the gut which is opposite the line of the mesenteric attachment. This is the reason why the student was directed to open the bowel along this line.

In the lower part of the ileum the patches may present a length of two or even four inches, and a breadth of about half-an-inch, but as we follow them up the tube into the jejunum they become much smaller and not nearly so numerous. The total number varies much, but the average number may be stated to be about thirty.

The *solitary glands* are isolated lymphoid follicles, scattered everywhere over the mucous membrane of the small intestine. They are minute, rounded or ovoid, opaque white bodies, about the size of a millet seed, and they usually cause a slight bulging of the mucous membrane at the points where they occur.

The *valvulæ conniventes*, the *villi*, and *Peyer's patches* are the only special peculiarities of the mucous membrane of the jejunum and ileum which are visible to the naked eye, and from what has been said regarding them the dissector will understand that although they are not arranged in such a way as mark off by a clear line of demarcation the jejunum from the ileum, they are sufficient to enable him to distinguish between characteristic portions of each—*i.e.*, between portions taken at some distance from the arbitrary line of division. The following are the essential points of difference which would guide him in deciding which was ileum and which jejunum :—

Jejunum.	Ileum.
Valvulæ Conniventes.	
Numerous and well marked.	Few in number and poorly developed or absent altogether.
Villi.	
Numerous and large.	Not so numerous and not so large.
Peyer's Patches.	
Few in number and small in size.	More numerous and of large size.

Great Intestine.—Ligature the great intestine about four inches above the entrance of the ileum, and divide the gut above this point. The nozzle of the bellows should now be introduced into the attached portion of ileum, and the cœcum inflated until its walls are tense. This portion of the intestine should then be hung up to dry. Next slit open the colon in the same manner as the small intestine and examine its inner surface. Transverse and oblique ridges or folds corresponding to the constrictions which separate the sacculi are everywhere apparent.

If the longitudinal bands of muscular fibres be removed or divided at short intervals and the gut stretched, both sacculi and constrictions disappear, and the wall of the bowel becomes uniform. The mucous membrane of the great intestine is absolutely destitute of *villi*, but *solitary glands* are present in considerable numbers.

Coats of the Large Intestine.—The coats of the large intestine must be dissected in the same manner as in the case of the small intestine. In connection with the *serous coat*, the student has already taken notice of the *appendices epiploicæ*. The *external longitudinal* muscular fibres have also been observed to be disposed in three flat bands. These are placed as follows:—(1.) One in relation to the attached surface; (2.) the second upon the anterior aspect; (3.) and the third along the inner aspect of the gut,—in the case of the transverse colon, this band is in relation to the inferior aspect of the tube. The *internal circular* muscular fibres are most distinct in the constrictions between the sacculi, but constitute a thin uniform layer over the entire extent of the gut. The *submucous coat* is in no respect different from the corresponding coat in the small intestine.

Ileo-cœcal Valve.—When the distended cœcum is dry, the ileo-cœcal valve should be examined. This can best be done by removing the outer wall of the cœcum. A window is thus made into the gut through which the opening of the ileum into the cœcum can be seen. This aperture is a narrow transverse slit guarded by a valve which consists of an upper and lower crescentic segment or fold of mucous membrane. At the extremities of the aperture these folds unite and are prolonged round the inner surface of the wall of the great intestine in the form of two ridges which are termed the *fræna* or *retinacula* of the valve.

The function of this valve is very obvious. It is so arranged that the free passage of materials from the ileum into the cœcum is in no way impeded, but when the cœcum becomes distended and there is consequently a tendency to regurgitation, the fræna of the valve are put upon the stretch, and the free borders of the segments brought into firm contact. In this way reflux of the contents of the cœcum into the ileum is effectually prevented.

The Cœliac Axis, the artery which supplies blood to the stomach, duodenum, spleen, and pancreas, should now be dissected. Pull the stomach downwards and tear through the two layers of peritoneum which form the gastro-hepatic omentum. The artery will be found by dividing the ascending layer of the transverse meso-colon along the upper border of the pancreas. This dissection will be facilitated if the liver is first raised and then fixed in this position, by stitching it to the lower margin of the thorax.

The cœliac axis is a short wide vessel, which springs from the front of the aorta, between the two crura of the diaphragm, opposite the lower border of the body of the last dorsal vertebra, and in immediate relation to the upper margin of the pancreas. It is directed horizontally forwards, and after a course of little more than half-an-inch divides into three large

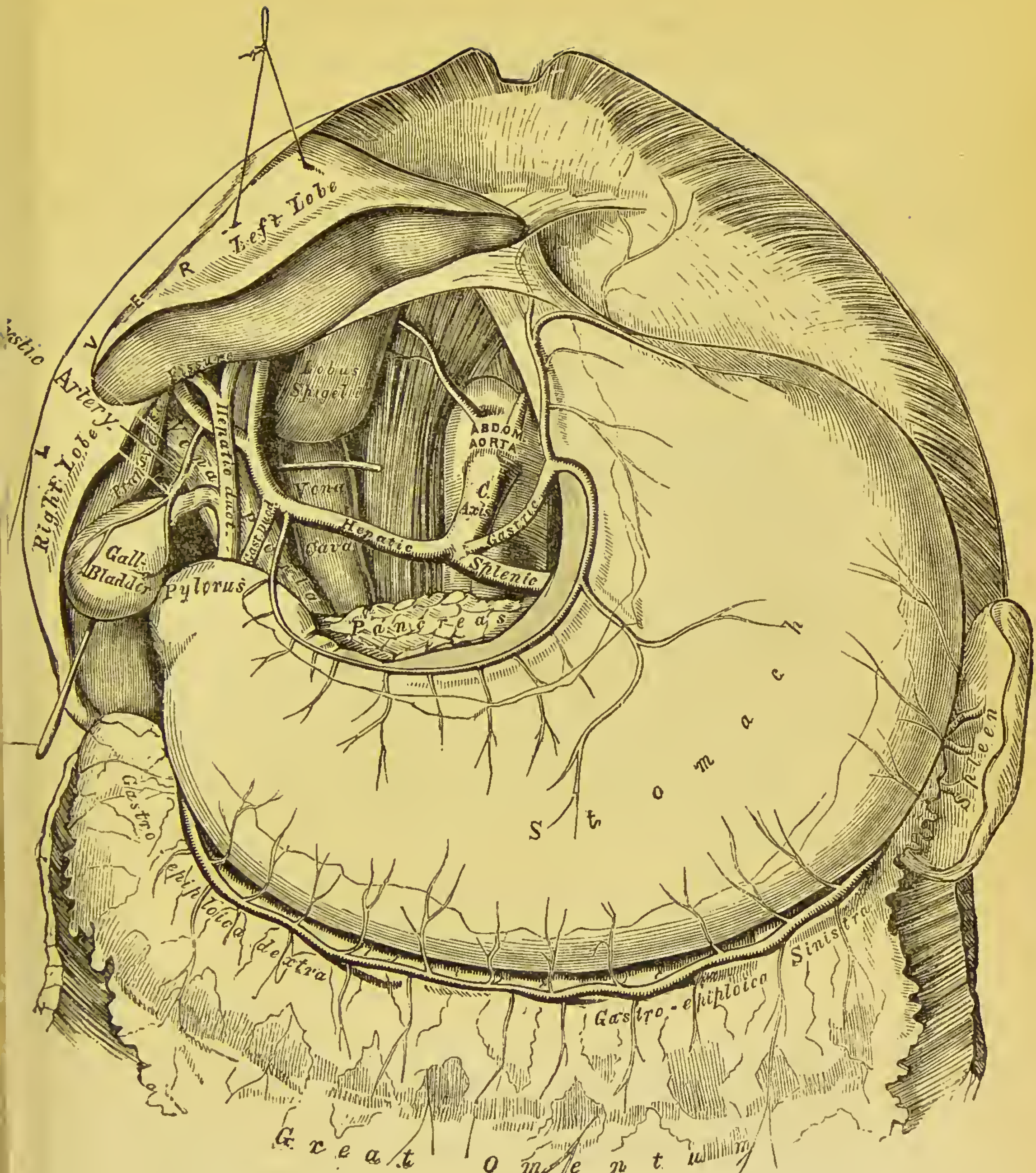


FIG. 29.

The cœliac axis and its branches. The gastro-hepatic omentum has been taken away and the liver raised.—*From* GRAY'S *Anatomy*.

branches, viz.:—(1.) the coronary, (2.) the hepatic, and (3.) the splenic, which radiate from each other like the spokes of a wheel. The cœliac axis is surrounded by a thick plexus of nerves, called the *cœliac plexus*, which sends numerous nervous twigs with the three branches which spring from the axis. The cœliac plexus must be left undisturbed, and in following the coronary, hepatic, and splenic arteries the nerves which accompany them must be carefully preserved.

The Coronary Artery, the smallest of the three branches of the cœliac axis, proceeds upwards and to the left to the œsophageal opening of the stomach. Here it changes its direction, enters between the two layers of the gastro-hepatic omentum, and runs from above downwards and to the right along the lesser curvature of the stomach. Near the pylorus it ends by anastomosing with the *pyloric* branch of the hepatic artery.

The branches of the coronary artery are:—

(1.) Œsophageal.
(2.) Gastric.

The *œsophageal arteries* spring from the coronary at the point where it reaches the stomach. They pass upwards upon the posterior aspect of the gullet, through the œsophageal opening of the diaphragm, and anastomose with the œsophageal branches of the thoracic aorta.

The *gastric branches* take origin from the coronary as it runs along the lesser curvature of the stomach, and are distributed to both surfaces of this viscus.

The Coronary Vein accompanies the artery of the same name along the lesser curvature of the stomach. At the pylorus it turns downwards and opens into the vena portæ.

The Hepatic Artery, intermediate in size between the coronary and splenic, at first takes a transverse course to the right. At the pyloric end of the stomach it changes its direction, and ascends between the two layers of the gastro-hepatic omentum, inclining at the same time forwards and to the right side. Near the transverse fissure of the liver it ends by dividing into *right* and *left hepatic* arteries. The hepatic artery is accompanied by numerous large nervous twigs derived from the cœliac plexus, and, as it passes upwards to the liver, it is in close relationship with the bile duct and the portal vein. The duct lies upon the right side of the artery, and the vein lies behind and between both. (Figs. 22 and 28.)

The following are the branches of the hepatic artery:—

(1.) Pyloric.

(2.) Gastro-duodenal. { Superior pancreatico-duodenal. / Right gastro-epiploic.

(3.) Hepatic. { Right. { Cystic. / Left.

The *pyloric* is a small artery which springs from the hepatic at the pylorus, and then runs from right to left along the lesser curvature of the stomach between the two layers of the gastro-hepatic omentum. It ends by inosculating with the coronary.

The *gastro-duodenal* arises close to the pyloric artery, and is directed downwards behind the first part of the duodenum, at the lower border of which it ends by dividing into the superior pancreatico-duodenal and the right gastro-epiploic.

The *superior pancreatico-duodenal* takes a curved course round the head of the pancreas, between it and the duodenum, to both of which it gives branches. It ends by inosculating with the *inferior pancreatico-duodenal* branch of the superior mesenteric artery.

The *right gastro-epiploic* is directed from right to left, along the greater curvature of the stomach, and between the two anterior layers of the great omentum. It gives branches upwards to both surfaces of the stomach, and downwards to the great omentum, and ends by anastomosing with the *left gastro-epiploic*, a branch of the splenic.

The *right* and *left hepatic* arteries, the terminal branches of the hepatic, diverge from each other, and sink into the liver at the two extremities of the transverse fissure. From the right hepatic a small branch called the *cystic* is given to the gall-bladder. This divides into two twigs, one of which ramifies in the areolar tissue between the liver and gall-bladder, and the other upon the dependent surface of the gall-bladder.

The *cystic vein* joins the vena portæ or its right branch.

The Splenic Artery, the largest branch of the cœliac axis, takes a wavy or tortuous course to the left side,

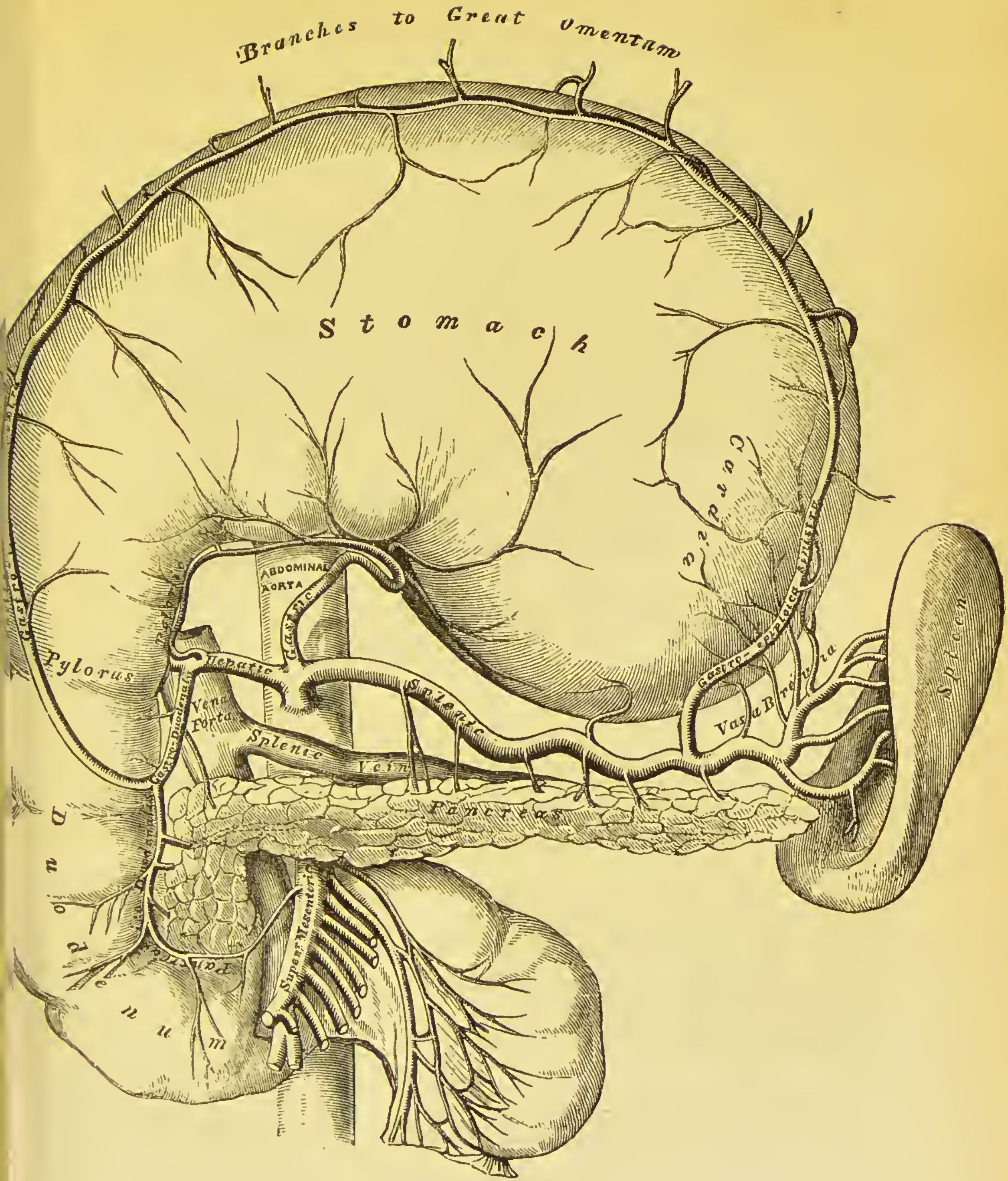


FIG. 30.

The stomach has been thrown upwards to show the cœliac axis and its branches the pancreas is drawn downwards to exhibit the splenic vein.—*From* GRAY'S *Anatomy*.

and ends near the spleen by dividing into five or six branches, which enter the organ on its concave surface.

To obtain a good view of the splenic artery, it is necessary to throw the stomach upwards towards the ribs. The vessel will then be seen to run along the upper border of the pancreas, which somewhat overlaps it. It is accompanied by the splenic vein, which, however, lies at a lower level, and therefore altogether behind the pancreas.

The following are the branches of the splenic artery:—

(1.) Pancreatic. { Pancreaticæ parvæ. / Pancreatica magna.

(2.) Gastric. { Vasa brevia. / Left gastro-epiploic.

(3.) Splenic.

The *arteriæ pancreaticæ parvæ* are small twigs which come off at various points for the supply of the pancreas. The *pancreatica magna* is a larger branch which arises from the splenic artery near its termination. It sinks into the pancreas, and is directed from left to right in the gland substance in company with the duct.

The *vasa brevia* are five or six small arteries, of which some arise directly from the splenic, whilst others take origin from its terminal branches. They run towards the stomach between the two layers of the gastro-splenic omentum, and are distributed to the cardiac end of this viscus, anastomosing with the coronary and left gastro-epiploic arteries.

The *left gastro-epiploic* takes origin from the splenic near the spleen, and is directed from left to right, along the greater curvature of the stomach, between the two anterior layers of the great omentum. It gives branches which ascend to supply both aspects of the stomach, and others which descend into the great omentum, and it ends by anastomosing with the right gastro-epiploic artery.

From the above description of the branches of the cœliac axis it will be seen that the stomach is remarkably rich in blood-vessels. *Two* proceed from *left to right*—viz., the *coronary* along the lesser curvature, and the *left gastro-epiploic* along the greater curvature; *two*, both branches of the hepatic, are directed from *right to left*—viz., the *pyloric*, in relation to the lesser curvature; and the *right gastro-epiploic*, in relation to the greater curvature. The arterial circle is completed on the left by the *vasa brevia*, which connect the coronary artery with the left gastro-epiploic.

The Splenic Vein, formed by the union of the veins which issue from the spleen, runs from left to right behind the pancreas, and at a lower level than the artery of the same name. After crossing the aorta and the root of the superior mesenteric artery, it ends in front of the vena cava by joining the superior mesenteric vein to form the vena portæ. In its course between the spleen and the vena portæ it receives the following tributaries:—(1.) veins corresponding to the vasa brevia; (2.) the left gastro-epiploic vein; (3.) pancreatic veins; (4.) the inferior mesenteric vein; (5.) some duodenal twigs.

Vena Portæ.—This is a most remarkable vessel. It arises after the manner of a vein, by gathering, by means of its rootlets, the blood from the capillaries of the entire abdominal portion of the alimentary canal (with the exception of the lower end of the rectum), the spleen, pancreas, and gall-bladder, whilst it ends in the liver after the manner of an artery, by pouring its blood into the hepatic capillaries. The blood which flows in the portal vein, therefore, passes through two series of capillaries before it is returned to the heart, viz.—(1.) the capillaries of the organ from which it is derived ; (2.) the hepatic capillaries.

The *portal vein* is formed behind the pancreas, between it and the vena cava, by the union of the splenic and superior mesenteric veins. From this it ascends, with an inclination to the right, and ends near the right extremity of the transverse fissure of the liver by dividing into a *right* and *left* branch, one for each lobe of this organ. After emerging from under cover of the pancreas, it lies first behind the ascending portion of the duodenum, and then between the two layers of the gastro-hepatic omentum, close to its right free margin. In the latter situation it is placed behind and between the hepatic artery and the bile duct, and is closely surrounded by the hepatic nerves and lymphatics. The vena portæ receives the coronary vein and the cystic vein. The latter, however, may join its right branch.

The branches of the portal venous system are devoid of valves, and we shall afterwards see that this is a great predisposing cause in the production of hæmorrhoids.

Duodenum.—The connections of the duodenum should next be studied, and the dissector will find it advantageous in doing this to partially inflate with air both it and the stomach.

The *duodenum*, or first part of the small intestine, is wider and more fixed in its position than either the

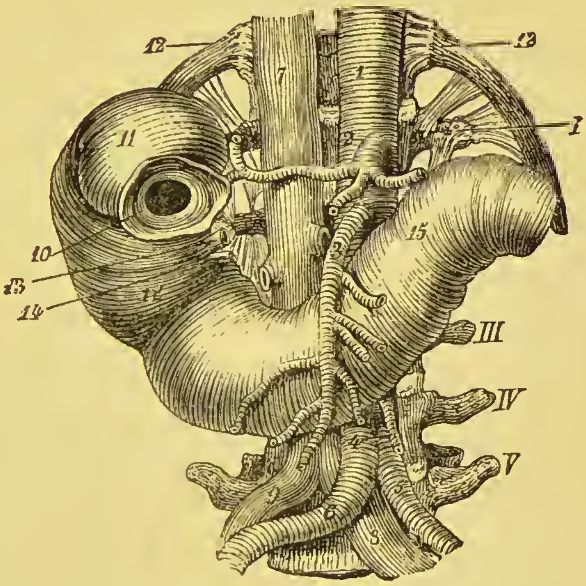


FIG. 31.
The duodenum.—*From* LUSCHKA'S *Anatomy.*

(1) Aorta.
(2) Cœliac axis.
(3) Superior mesenteric artery.
(4) Inferior mesenteric artery.
(5) Left common iliac.
(6) Right common iliac.
(7) Vena cava inferior.
(8) Left common iliac vein.
(9) Right common iliac vein.
(10) Pyloric valve.
(11) Ascending part of duodenum.
(12) Descending part of duodenum.
(13) Common bile duct.
(14) Pancreatic duct.
(15) Transverse part of duodenum, at the point where it becomes jejunum.

jejunum or ileum. It is ten to twelve inches in length, and extends from the pylorus of the stomach to the left side of the second lumbar vertebra, where it becomes continuous with the jejunum. Between these points it describes a curve like a horse shoe, the convexity of which is directed to the right, whilst the concavity looks to the left and embraces the head of the pancreas. For convenience in description, the duodenum is divided into an *ascending* or *first* part, a *descending* or *second* part, and a *transverse* or *third* part.

The *ascending part* of the duodenum begins in the epigastric region at the pyloric end of the stomach, and extends from this upwards, backwards, and to the right, into the right hypochondrium. It ends at the neck of the gall-bladder by bending downwards. This portion is completely enveloped by peritoneum, being enclosed like the stomach between the two anterior layers of the great omentum. It is therefore freely moveable. Its relations are—*above and in front*, the under surface of the liver and the gall bladder; *behind*, the vena portæ, the gastro-duodenal artery, and the bile duct. It is usually found deeply stained from transudation of bile from the gall-bladder.

The *descending part* extends vertically downwards from the right hypochondrium into the right lumbar region as far as the level of the third lumbar vertebra, at which point it ends by turning to the left. It is fixed in position, the peritoneum covering its anterior surface only. The common bile duct and the pancreatic duct open into the inner aspect of this portion of the duodenum a little below its middle, and this shows the necessity of its being fixed and immoveable. Its relations are—*in front*, the colon; *behind*, the right kidney, to which it is connected by areolar tissue; *to the left*, the head of the pancreas.

The *transverse part* begins on the right side of the third lumbar vertebra, and extends upwards and to the left, across the spine and through the umbilical region, to the left side of the second lumbar vertebra, where it ends in the jejunum. The extremity of the duodenum is supported in this position by a band of non-striated muscular fibres, called the *suspensory muscle*, which descends from the cœliac axis and the left crus of the diaphragm. This part of the duodenum is only partially covered by peritoneum. It lies between the two layers of the transverse meso-colon, where they reach the spine, and the descending layer of this fold is borne off its anterior aspect by the superior mesenteric vessels. *Behind* the third part of the duodenum are the vena cava and the left renal vein, the aorta and the two crura of the diaphragm; *in front* it is crossed by the superior mesenteric artery and vein; *above* it is in contact with the lower border of the pancreas.

The Pancreas is a flattened elongated gland which stretches across the posterior wall of the abdomen at the level of the first lumbar vertebra. Its enlarged right extremity, which is termed *the head*, is embraced by the concavity of the duodenum; its tapering left extremity, called *the tail*, is in contact with the lower part of the concave surface of the spleen. Its position is therefore somewhat oblique, its tail being higher than its head. The relations of this gland are very complicated. Its *anterior surface* is separated from the posterior aspect of the stomach by the lesser bag of the peritoneum, and is covered by the ascending layer of the transverse meso-colon. The *posterior surface* is in contact from right to left with—(1.) the bile duct;

(2.) the vena cava and vena portæ ; (3.) the crura of the diaphragm, and between these the aorta and the root of the superior mesenteric artery ; (4.) the left kidney and the left suprarenal capsule. It must also be borne in mind that the splenic vein runs behind the gland, and that the two mesenteric veins, in passing up to join this, dip behind its lower border. Its *upper border*, in the middle line of the body, abuts against the cœliac axis, and to the left of this it is in relation to the splenic artery. Its *lower border* is related to the transverse part of the duodenum, but is separated from it to a certain extent by the superior mesenteric vessels. Sometimes, however, this artery is enclosed in a tube of gland substance.

The *duct of the pancreas*, called the *canal of Wirsung*, is embedded in the gland substance. It begins at the tail and runs towards the head, somewhat nearer the lower than the upper border. By dividing the gland, therefore, horizontally along this line, little difficulty will be experienced in discovering it. The extreme whiteness of its walls, and the fact that it is accompanied by the pancreatica magna artery, are a great help to the student in this dissection. As it approaches the head of the gland it will be observed to gain considerably in diameter, from its being joined by the small ducts which come from the various groups of lobules. Close to the duodenum it comes in contact with the common bile duct, and bending downwards they both pierce in company the coats of the descending part of the duodenum upon its inner aspect, and open into the gut by a common orifice.

The Hepatic Ducts may next be examined. Leaving the transverse fissure of the liver, the student will notice two ducts called respectively the *right* and *left* hepatic ducts. These soon unite to form the *hepatic duct*, which in turn is shortly joined by the *cystic duct* of the gall-bladder. The junction of the cystic and hepatic ducts gives rise to the *common bile duct*, or the *ductus communis choledochus*, and this descends between the two layers of the gastro-hepatic omentum to the right of the hepatic artery and in front of the vena portæ. Passing behind the duodenum and the head of the pancreas, it ends by opening, as we have already seen, into the second part of the duodenum.

The attention of the student should now be directed to the ending of the vagi nerves within the abdominal cavity, and also to the great epigastric or solar plexus of the sympathetic. For the proper display of these it is necessary to divide the gastro-duodenal artery, the common bile duct, and the portal vein at the level of the upper border of the first part of the duodenum, and then, having allowed the air to escape from the stomach and duodenum, to throw both, along with the pancreas, over to the left side of the body. The dissection of the solar plexus is a very tedious one, because mingled with the nerves, which are soft and easily broken, are several lymphatic glands and a quantity of tough areolar tissue.

Pneumogastric or Vagi Nerves.—These enter the abdomen through the œsophageal opening of the diaphragm. The *left vagus* will be found lying upon the anterior aspect of the gullet. Trace it downwards and notice that it breaks up into branches, the great bulk of which spread out upon the anterior wall of the stomach; a few, however, run to the right, along the lesser curvature, and establish communications with the *coronary plexus*, whilst others ascend between the two layers of the gastro-hepatic omentum to reinforce the *hepatic plexus*. The *right vagus* lies upon the posterior aspect of the gullet, and at once breaks up into numerous branches which ramify upon the posterior wall of the stomach; it also sends twigs to the *cœliac plexus* and to the *splenic plexus*.

The Solar or Epigastric Plexus.—In connection with the sympathetic system three large plexuses are formed in front of the vertebral column—viz., the *cardiac plexus* in the thorax, the *solar plexus* in the abdomen proper, and the *hypogastric plexus* in the pelvis. These collectively receive the name of the prevertebral plexuses.

The *solar plexus* is by far the largest of the three. It is situated behind the stomach, in front of the aorta and the pillars of the diaphragm. Upon each side it extends as far as the suprarenal capsule, whilst inferiorly it is limited by the pancreas. On each side of the body, where it lies upon the crus of the diaphragm, a large ganglionic mass, called the *semi-lunar ganglion*, is developed in its midst.

Distinctive terms are applied to different parts of the plexus. The portion which connects the semi-lunar ganglia and surrounds the cœliac axis is called the *cœliac plexus.* To the outer side of each ganglion the plexus ends in numerous branches for the suprarenal body and kidney, and these are classified under the terms of *suprarenal* and *renal plexuses.* Inferiorly, the plexus has already been seen to send downwards two large offshoots to accompany the aorta and the superior mesenteric artery; these are the *aortic* and *superior mesenteric plexuses.* Lastly, a small offset from the upper part of each semi-lunar ganglion is termed the *diaphragmatic plexus.*

Semi-lunar Ganglia.—These are so large that they are usually mistaken by students for lymphatic glands. The ganglion of the right side is placed under cover of the vena cava inferior, and both lie in close relation to the cœliac axis. When thoroughly defined, they will be observed to be of a very irregular shape, and to show little of the outline from which their name is derived. The upper extremity of each ganglion is joined by the *great splanchnic nerve.*

The Cœliac Plexus.—This plexus of nerves connects the two semi-lunar ganglia with each other, and surrounds the cœliac axis so closely that it almost completely hides its trunk from view. It is reinforced by twigs from the *right vagus* and is joined by the *small* or *second splanchnic nerve.* Three secondary plexuses —viz., the coronary, the hepatic, and the splenic—take origin from the cœliac plexus.

The *coronary plexus* accompanies the artery of the same name along the lesser curvature of the stomach, and distributes twigs to both aspects of the viscus.

The *hepatic plexus* follows the hepatic artery, the vena portæ, and the bile duct to the transverse fissure of the liver. It is joined by twigs from the left pneumogastric, and also from the right diaphragmatic plexus, and it gives origin to the *pyloric*, *right gastro-epiploic*, *superior pancreatico-duodenal*, and *cystic plexuses*, which accompany the arteries of the same names.

The *splenic plexus* is prolonged along the splenic artery to the spleen. It is joined by twigs from the right pneumogastric, and gives off branches to the pancreas and to the fundus of the stomach, and also the *left gastro-epiploic plexus*.

Renal Plexus.—This consists of numerous nerves which spring chiefly from the outer part of the semilunar ganglion. Some will be found, however, coming from the cœliac and others from the aortic plexus. The *smallest* or *third splanchnic* nerve, when it is present, joins this plexus. Thus constituted, the filaments of the renal plexus run with the renal artery to the hilus of the kidney, and are distributed to the gland substance. Several twigs are likewise given to the spermatic plexus. A few scattered ganglia are usually found in connectlon with the renal plexus.

Suprarenal Plexus.—The dissector will no doubt be struck with the large number of nerves which supply the suprarenal body. The plexus seems altogether out of proportion to the small organ to which it is distributed. The nerves composing it are chiefly derived from the semi-lunar ganglion, but many come from the cœliac plexus. Below, it is directly continuous with the renal plexus, and above it is connected with the diaphragmatic plexus. The smallest splanchnic nerve usually contributes branches to this plexus, and the point at which they join is marked by a small ganglion.

Diaphragmatic Plexus.—The filaments composing this plexus take origin from the upper part of the semi-lunar ganglion, and are distributed with the phrenic artery to the under surface of the diaphragm, but they do not follow rigorously the branches of this vessel. At first they lie subjacent to the peritoneum, but soon they penetrate between the fleshy fibres and establish communications with the phrenic nerve. On the right side a small ganglion is formed on the under surface of the diaphragm at the point of junction between this plexus and the phrenic. In addition to its diaphragmatic branches, it contributes filaments to the suprarenal plexus, and on the right side to the hepatic plexus.

Apply two ligatures to the œsophagus, where it enters the stomach, and divide it between them. The stomach, duodenum, pancreas, and spleen may now be removed by dividing the vessels, nerves, and peritoneal folds which still hold them in position.

The Spleen.—A very limited idea of the internal structure of this organ can be obtained in the dissecting-rooms. It is enveloped by two coats—(1.) serous; (2.) fibro-elastic. The *peritoneal investment* adheres so closely to the subjacent fibrous coat that it can only be removed with difficulty. With regard to the *fibro-elastic* tunic, it should be noted that processes proceed from its deep surface and dip into the substance of the organ. These are the *trabeculæ*, and they constitute the supporting framework of the *gland-pulp*. On account of this arrangement it will be found utterly impossible to strip off the fibrous coat of the spleen without at the same time lacerating its surface. Make a section through the organ, and carry a portion of it to the tap. By squeezing it and allowing the water to run freely over it, a partial view of the trabecular framework may be obtained.

Stomach and Duodenum.—Detach the pancreas from the duodenum, but leave a portion of the duct in connection with the gut. Next clean out the stomach and duodenum by allowing water to run freely through them, and then render their walls tense by inflating them with air.

The *coats* of the stomach should now be examined. They are five in number, viz.:—

(1.) Peritoneal, or serous.
(2.) Subserous.
(3.) Muscular.
(4.) Submucous.
(5.) Mucous.

The *serous coat*, derived from the peritoneal membrane, can be best stripped off with the fingers. The *subserous coat* is composed of a little areolar tissue which intervenes between the muscular and serous strata.

The *muscular coat* consists of involuntary or unstriped muscular fibres, and these are disposed in three layers—each layer being distinguished by the direction of its fibres. The *external layer* is composed of longitudinal fibres. These are best seen at the curvatures and towards the pylorus. At the cardiac orifice they become continuous with the longitudinal fibres of the œsophagus, and at the pyloric orifice they mix with the longitudinal fibres of the duodenum. Very few longitudinal fibres can be detected on the anterior and posterior surfaces of the viscus. The *middle layer* is composed of circular fibres, and these constitute a uniform coating for the stomach. Very thin at the fundus, this layer becomes gradually thicker as we approach the pylorus, and, at the point where the stomach gives place to the duodenum, they are aggregated into a circular band, called the *pyloric sphincter*. The *internal layer* consists of oblique fibres, and only gives a partial covering to the stomach. They are continuous with the circular fibres of the gullet, and are best seen on the fundus of the stomach to the left of the œsophageal opening. From this they spread out upon both surfaces of the viscus, and embrace the œsophageal opening.

The *submucous coat* is composed of loose areolar tissue. It intervenes between the muscular and mucous tunics, and binds the one to the other.

The *mucous coat* must be studied from the inside of the stomach. Open up the viscus by running the scissors along the lesser curvature. The duodenum may be laid open at the same time. The gastric mucous membrane will now be seen to be thick, soft, and pulpy. In the dissecting-rooms the student cannot obtain a proper idea of its natural colour. In infancy it is rosy red, but as life advances it gradually becomes paler, and in old age it always presents a brownish hue from the presence of pigment. When the stomach is empty the mucous membrane is thrown into longitudinal folds or rugæ, but these disappear when the organ is distended. During life the mucous membrane of the stomach is thickest at the cardiac end, but after death it is always thinned at this point by *post-mortem* digestion. At the pylorus the mucous membrane is raised into a remarkable circular fold, called the *pyloric valve* (Fig. 31, p. 169). This fold contains between its two layers the sphincter pylori muscle.

Duodenum.—In connection with the duodenum, note that the valvulæ conniventes begin about one or two inches beyond the pylorus, about the commencement of its second part; that the mucous membrane is covered by villi; and that usually no Peyer's patches are to be seen. Pass a probe along the bile duct, and another along the pancreatic duct. These ducts will then be observed to pierce the coats of the duodenum, side by side, very obliquely, and to open by a common orifice, which is placed on the summit of a papillary projection of mucous membrane.

Removal of the Liver.—The student has already examined the position and connections of the liver (p. 118). It should now be removed from the abdominal cavity, in order that he may study its form and the manner in which the vessels are distributed in its substance. Begin by dividing the ligamentum teres and the falciform ligament. Then drawing it downwards, cut through the lateral ligament on each side and the upper layer of the coronary ligament. Having done this, the bare area on its posterior border can be separated from the diaphragm with the handle of the knife. Observe that this portion of the liver is merely connected to the diaphragm by areolar tissue. Soon the vena cava inferior will be exposed, emerging from the posterior border of the liver, and then piercing the central tendon of the diaphragm. This must be severed. On dividing the lower layer of the coronary ligament, the liver will be free from all the surrounding parts, except the vena cava, at the point where it first comes in contact with the organ. The vena cava must, therefore, be cut a second time, and thus a portion of the vessel is taken away with the gland.

Form of the Liver.—The *liver* is so irregular in form, that there is no object with which it can properly be compared. Its transverse diameter measures about 10 to 12 inches, and its antero-posterior diameter from 6 to 7 inches. Its average weight may be stated to be somewhere between 50 to 60 ounces; or, as Bartholin has computed it, about 1-36th of the total weight of the body. It is a solid, pliant organ, which readily adapts itself to changes in the bulk or position of the neighbouring viscera, and it has a dull reddish-brown colour.

In studying the liver, it is necessary to recognise *two borders*, *two extremities*, and *two surfaces*, and to examine each separately.

The *borders* stand out in marked contrast to each other. The *anterior* is thin, sharp, and free, whereas the *posterior* is thick, rounded, and attached. Note further, that the sharp anterior border presents two notches, one opposite the ninth costal cartilage for the fundus of the gall-bladder, the other, deeper and better marked, opposite the falciform ligament, in which is lodged the ligamentum teres. The rounded posterior border, on the other hand, is slightly depressed by the spinal column, and also to the right of this it is notched by the vena cava. This border has been seen to be attached to the diaphragm by the lateral and coronary ligaments (p. 143), by areolar tissue, and by the vena cava.

The *two extremities* are also very different from each other. The *right* is thick and rounded, like the posterior border, whilst the *left* is thin and attenuated, like the anterior border.

The *superior surface* is smooth and convex, and is moulded upon the under surface of the diaphragm. In connection with this surface is the falciform or broad ligament, which marks the subdivision of the organ into two unequal parts—a large right lobe and a small left lobe. The convexity of the upper surface of the liver is not by any means uniform. In the right lobe it is high and prominent, so as to fit into the right vault of the diaphragm; in the case of the left lobe, however, the surface is very nearly even.

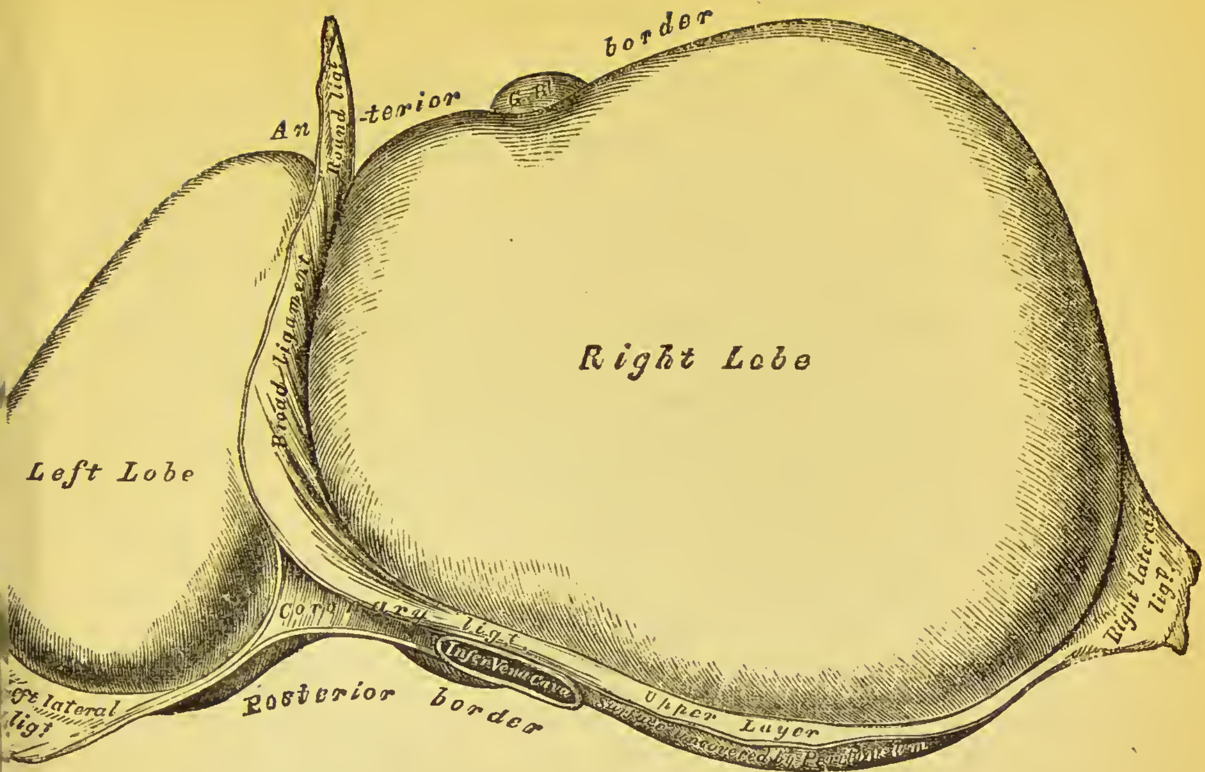


FIG. 32.
Upper surface of the liver.—*From* GRAY'S *Anatomy.*

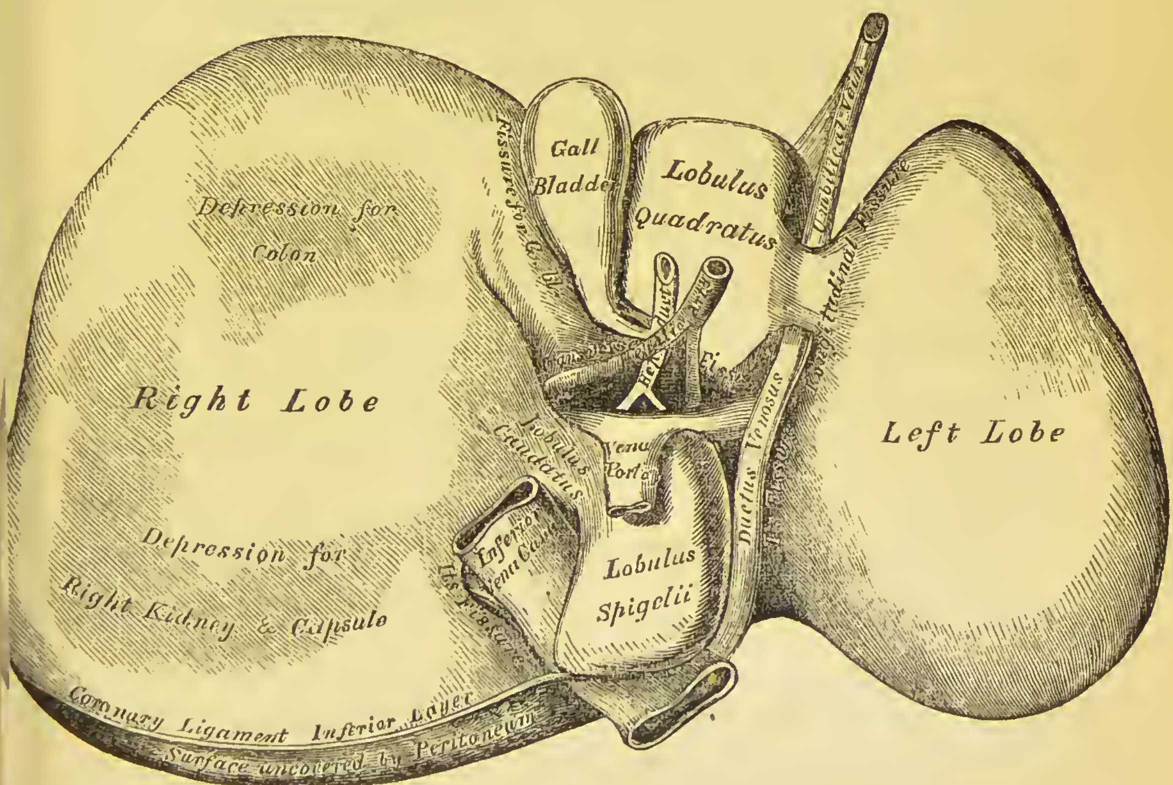


FIG. 33.
Lower surface of the liver.—*From* GRAY'S *Anatomy.*

The *inferior surface* is somewhat concave, and rendered highly irregular, from the presence of fissures and lobes. No less than *five* fissures are to be seen, viz.:—

(1.) The longitudinal { fissure for umbilical vein. / fissure for ductus venosus.

(2.) The transverse.

(3.) The fissure or fossa for the gall-bladder.

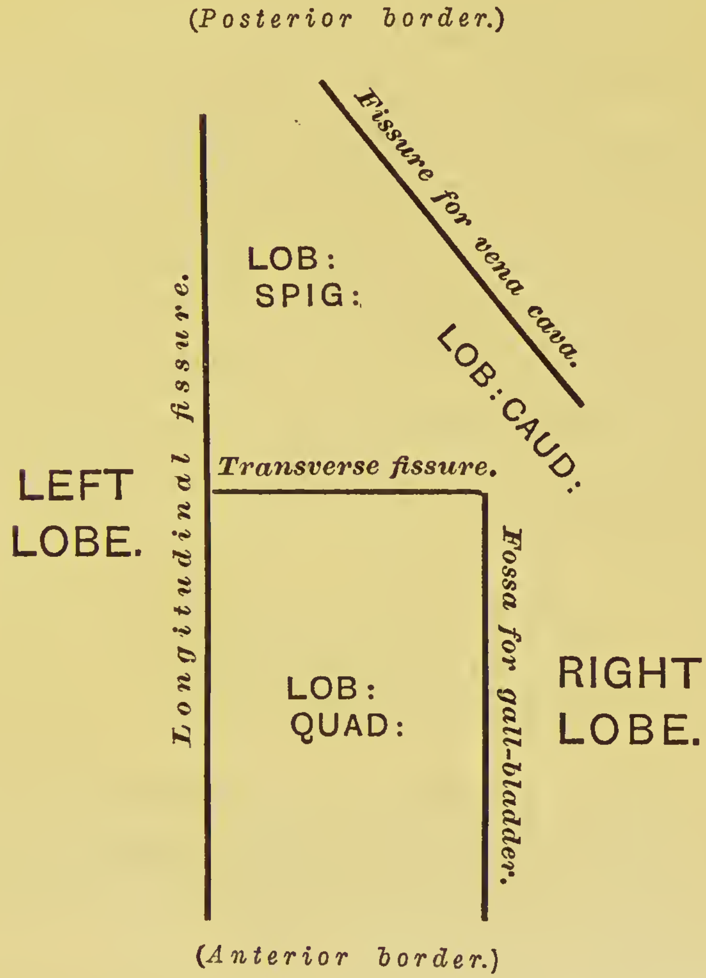
(4.) The fissure or fossa for the vena cava.

The *longitudinal fissure* traverses the under surface of the liver, from the anterior to the posterior border, along a line which corresponds with the line of attachment of the falciform ligament on the superior surface. It, therefore, is the indication on this aspect of the organ of a subdivision into a right and left lobe. The anterior part of this fissure receives the special name of the *umbilical fissure* because it holds the ligamentum teres, or the remains of the umbilical vein, whilst the posterior part of the longitudinal fissure is called the *fissure for the ductus venosus*, on account of its being occupied by the fibrous cord, which in the adult represents this vessel. The umbilical fissure is frequently bridged over by liver substance, and this link between the right and left lobes is termed the *pons hepatis.**

The *transverse fissure* is the deep depression or hilus at which the portal vein and the hepatic artery,

* The *umbilical vein* is the vessel which, during the intra-uterine life of the fœtus, returns the purified blood from the placenta. It enters the abdominal cavity at the umbilicus, and ascends to the longitudinal fissure on the under surface of the liver, along the free margin of the falciform ligament. After giving some branches to the right and left lobes of this organ, it ends by dividing into two branches; of these,

nerves, and lymphatics enter, and the bile ducts leave the liver. In consequence of this it is often spoken of as the "gate," or "porta" of the gland. Beginning at the longitudinal fissure, a little nearer the posterior than the anterior margin, it extends transversely to



the right for a distance of two inches, and there ends abruptly.

one is joined by the portal vein (at this period very small) and enters the right lobe, whilst the other is continued onwards as the *ductus venosus* to unite with the vena cava inferior at the posterior border of the liver. Between the second and fifth days after birth the umbilical vein and the ductus venosus become obliterated, and in the adult they are merely represented by the fibrous cords mentioned above.

The *fossa for the gall-bladder*, parallel to the umbilical fissure, extends upon the under surface of the right lobe from the anterior border to a point near the right extremity of the transverse fissure.

The *fissure for the vena cava* begins a little way behind the right extremity of the transverse fissure, and extends obliquely backwards and to the left to the posterior border of the organ, where it ends close to the fissure for the ductus venosus. Not unfrequently this fissure, like the umbilical fissure, is converted into a canal by a bridge of hepatic substance.

The hepatic fissures, therefore, with the exception of the longitudinal, which lies between the two primary lobes, are entirely confined to the under surface of the right lobe, and upon this they mark off *three* subsidiary lobes, viz. :—

(1.) The lobulus quadratus.
(2.) The lobulus Spigelii.
(3.) The lobulus candatus.

The *lobulus quadratus*, quadrilateral in form, is bounded *behind* by the transverse fissure, *to the right* by the fossa for the gall-bladder, and *to the left* by the umbilical fissure.

The *lobulus Spigelii* is a prominent and irregular portion of liver substance, which projects from the back part of the right lobe *behind* the transverse fissure. *To the left* it is limited by the fissure for the ductus venosus; *to the right* by the fissure for the vena cava.

The *lobulus candatus* is a slight ridge of liver substance which connects the Spigelian lobe with the general mass of the right lobe. It extends obliquely forwards and to the right, between the extremity of the transverse fissure and the commencement of the fissure for the vena cava.

To the right of these subsidiary lobes the under surface of the right lobe presents two slight hollows, of which the anterior corresponds to the hepatic flexure of the colon and the posterior to the right suprarenal capsule and kidney.

Gall-Bladder and Bile Ducts.—The gall-bladder is a pyriform membranous bag placed in a depression on the under surface of the right lobe of the liver. Its form and position can be seen to best advantage by inflating it with air through the bile duct. It lies somewhat obliquely, its great end or *fundus* free and covered by peritoneum, being directed downwards, forwards, and to the right, so as to project slightly beyond the anterior border of the liver, whilst its narrow extremity or *neck* ends near the right end of the transverse fissure, by making a double bend like the letter S, and then becoming continuous with the *cystic duct.* The *upper surface* is in contact with the liver, to which it is connected by areolar tissue. The *under surface* is clothed by peritoneum, and is in relation in front to the transverse colon, and behind to the first part of the duodenum.

The *cystic duct* has already been observed to proceed downwards and to the left to join the hepatic duct, and thereby form the common bile duct. The *right* and *left hepatic* ducts issue from the extremities of the transverse fissure, and unite to form the hepatic duct. To see these points, it will be necessary to remove a sheath of areolar tissue which surrounds the hepatic ducts and vessels, and which is termed *Glisson's capsule.*

If the dissector now investigates the composition of the wall of the gall-bladder, he will find that, in addition to its partial serous covering, it has—(1.) a strong coat composed of muscular and white fibrous tissue, and (2.) an internal mucous coat. The first can be seen by stripping off the peritoneum, and the second is best displayed by laying open the gall-bladder with a pair of scissors. The mucous membrane will then be seen to be elevated into ridges which join with each other so as to form an alveolar arrangement—the meshes or depressions having a polygonal form. The cystic duct should also be laid open, when the mucous membrane in this will be observed to be raised into oblique crescentic folds, which, when viewed collectively, have a spiral appearance.

The Vessels of the Liver.—Blood enters the liver—(1.) by the *hepatic artery*, (2.) by the large *portal vein;* whilst it is led away from the liver by the *hepatic veins.*

The *hepatic artery* is a branch of the cœliac axis, and carries arterial blood for the nourishment of the liver substance. The *portal vein* carries venous blood, which it has gathered from the entire length of the abdominal portion of the alimentary canal (with the exception of the lower end of the rectum), from the spleen, pancreas, and gall-bladder. As we have already seen, both artery and vein enter the liver at the transverse fissure, after dividing into right and left branches.

Note particularly the relative position of the *vein*, *artery*, and *duct* at the transverse fissure. The duct is placed *in front*, the vein *behind*, whilst the artery is *intermediate* in position. They and their branches are all enveloped in a common fibrous sheath called Glisson's capsule. Trace them into the liver substance for a short distance. The portal vein branches like an artery, and, wherever it divides, there also will the hepatic artery and hepatic duct be found to divide. The branches of these three structures, therefore, traverse the liver substance in company, and Glisson's capsule is prolonged into the liver with them, and follows them in their ramifications. The student is now in a position to understand the meaning of the term "*portal canal*." It is employed to denote a channel in the liver substance lined by a prolongation of Glisson's capsule, and holding in its interior a branch of the portal vein, a branch of the hepatic artery, and a branch of the hepatic duct.

The *hepatic veins* which lead the blood out of the liver have an arrangement altogether different from the vessels which enter at the transverse fissure. They converge towards the posterior border of the organ, and cannot be said to have any course outside the liver, as they open directly into the vena cava inferior. The vena cava should be slit open, when the wide gaping mouths of the terminal hepatic veins will be displayed. Trace these veins for a short distance into the substance of the gland. They are remarkable for the great tenuity of their walls, and also for the very small quantity of areolar tissue which separates them from the hepatic substance; indeed this is so scarce that it is hardly appreciable to the naked eye. In the case of the smaller veins it is altogether absent, and the hepatic lobules rest directly upon the wall of the vessel.

A section should now be made through the liver substance and the cut surface examined. The portal veins can be readily distinguished from the hepatic veins. The following are the points of difference:—

Portal Veins.	Hepatic Veins.
(1.) Are always accompanied by a branch of duct and a branch of hepatic artery.	(1.) Are solitary and not accompanied by any vessel.
(2.) Mouths collapsed.	(2.) Mouths open and gaping.
(3.) Walls thicker.	(3.) Walls exceedingly thin.
(4.) Walls separated from the liver substance by Glisson's capsule.	(4.) Walls apparently in direct apposition with the liver substance.

The Kidneys.—The kidneys are situated behind the peritoneum, against the posterior wall of the abdomen—one in each lumbar region. They are enveloped by a thick capsule of loose areolar tissue, the meshes of which are usually loaded with soft pliable fat. Clear this away, and be careful not to remove at the same time the *suprarenal body*, which lies upon the upper end of each kidney, or to injure the fascia covering the quadratus lumborum and psoas muscles.

The *kidney* is placed opposite the bodies of three and a-half vertebræ. It extends from the upper border of the last dorsal vertebra to the middle of the body of the third lumbar vertebra, and it lies obliquely —its upper end being somewhat nearer the mesial plane than its lower end. Its average length is four inches; its breadth two and a-half inches; and its average weight four and a-half ounces in the male, but somewhat less in the female. It is a solid organ, firm in consistence, and of a brownish-red colour.

The *form* of this kidney is so characteristic that the term "reniform," or "kidney-shaped," has become very common in descriptive language. The *anterior surface*, full, rounded, and convex, looks forwards and outwards; whilst the *posterior surface* is flattened, and directed backwards and inwards. The *extremities* are round, but the superior end is thicker and more massive than the inferior, which is somewhat pointed. The *external border*, smooth and convex, is directed outwards and backwards; whilst the *internal border* is concave, and looks forwards and inwards.

The internal border presents a longitudinal fissure called the *hilus*, for the admission and egress of the vessels, nerves, lymphatics, and duct. This is bounded anteriorly and posteriorly by a thick lip, and leads into a deep recess in the kidney, which is called the *sinus*. Clean the ureter and vessels at the hilus. They will be found to have the following position from before backwards :—

(1.) Branches of the renal vein.
(2.) Branches of the renal artery.
(3.) Ureter or renal duct.

In detailing the *relations* of the kidney, we shall first take note of those which are common to both. *In front*, the kidney is in contact on each side with the colon—on the right side with the ascending colon, and on the left side with the descending colon. The peritoneum has a very limited and a very variable relation to this surface. *Behind*, the posterior surface rests upon the pillar of the diaphragm and upon the quadratus lumborum and psoas muscles, separated from these, however, by the fascia which covers them. *Superiorly*, the upper end is capped by the suprarenal capsule, which also descends for a short distance on its anterior surface; whilst *inferiorly*, the lower pointed extremity is separated by a short interval from the iliac crest. It is in this interval on the left side that the operation of colotomy is performed.

The relations which are special to each kidney are :—(1.) *On the right side*, the anterior surface of the kidney is in contact with the second part of the duodenum as well as the colon, and its upper end is in relation to the under surface of the right lobe of the liver upon which it leaves its mark in the form of a depression. (2.) *On the left side*, the pancreas is in relation to the anterior surface, and the spleen to the upper end of the kidney.

But the two kidneys also show a difference in *shape* and *position*. The *left kidney* is longer and narrower, and at the same time it is placed at a slightly higher level—reaching to the upper border of the eleventh rib; whereas the *right kidney* only reaches to the middle of the corresponding rib of the other side.

Keeping these facts in mind, the student can never experience any difficulty in determining the side to which a given kidney belongs. Even allowing that the upper end cannot be distinguished from the lower end, or the anterior surface from the posterior surface, by differences in their appearance (which is often the case in a dissecting-room kidney), the ureter alone is sufficient for the purpose. It shows the posterior surface from its position at the hilus and the lower end from its curving downwards towards it.

Kidney Capsule and Kidney Substance.—The kidney is invested by a strong fibrous coat, which can be easily stripped from its surface. Divide this capsule along the external margin of the organ and peel it off towards the hilus. Here it enters the sinus and becomes continuous with the sheaths of the vessels entering the gland and with the external coat of the ureter.

The kidney should now be cut into two in the longitudinal direction. Use a large knife, and, entering it at the external border, carry it steadily through the gland substance to the hilus. This being done, examine in the first place the manner in which the ureter or duct is connected with the kidney. As it approaches the hilus it expands into a wide funnel-shaped portion called the *pelvis*. This enters the sinus and breaks up into two, or perhaps three, large primary branches, and these again break up into a large number of short stunted secondary divisions called *calices* or *infundibula*, which are attached to the walls of the sinus.

An examination of the cut surface of the kidney will show that its substance is arranged in two parts —a medullary and a cortical. The *medullary portion* is situated next the sinus, and is seen to consist of pyramidal masses, the bases of which are directed towards the periphery, whilst their apices are free and project into the sinus. On the sinus wall each appears in the form of a prominent mamillary process, called a *papilla*, which projects into one of the calices of the pelvis of the ureter. If the kidney be squeezed, fluid will be seen to exude from these papillæ, showing that the tubuli uriniferi open upon their surface. The *cortical substance*, which constitutes the peripheral part of the gland, is about two lines in depth, and it will be observed to send prolongations inwards between the pyramids. These are called the *columns of Bertin*.

The Ureter.—This is the duct which carries the urine from the kidney to the bladder. The relations of its expanded upper end or pelvis at the hilus of the kidney have already been noted. Leaving the gland, it turns downwards and becomes contracted, so that when it reaches the level of the lower end of the organ it has acquired the appearance of a cylindrical tube. The ureter extends downwards and inwards upon the psoas muscle, and, crossing the common or external iliac artery, it enters the pelvis, where it will be afterwards followed. In the abdomen proper it is placed immediately behind the peritoneum, and is crossed obliquely by the spermatic vessels. Before entering the pelvis it passes behind the ileum on the right side and the sigmoid flexure of the colon on the left side.

The Suprarenal Capsules are two small flattened triangular bodies, each of which is placed upon the upper end of the kidney. They surmount the kidney after the fashion of a helmet, and are prolonged downwards for a short distance upon its anterior surface. The suprarenal body rests upon the upper part of the pillar of the diaphragm. On the right side its anterior face is in relation to the under surface of the liver, and on the left side to the pancreas and spleen. The student has already observed its abundant nerve supply from the solar plexus. Its blood supply is equally rich. No fewer than three arteries enter its substance — viz., *the superior*, *middle*, and *inferior capsular* arteries.

The Diaphragm.—Having now disposed of all the viscera within the cavity of the abdomen proper, the student should in the next place direct his attention to the diaphragm—the great muscle which constitutes a moveable partition between the thoracic and abdominal cavities. Stripping the peritoneum from its lower concave surface, clean the muscular fibres and the central tendinous expansion towards which they ascend. In making this dissection be careful not to injure the phrenic arteries which ramify upon this aspect of the diaphragm or the nerves which accompany them.

The *diaphragm*, as Haller has put it, is, after the heart, the most important muscle in the body. It forms the dome-shaped roof of the abdomen, and the highly arched and convex floor of the thorax. It is the chief muscle of inspiration. Each respiratory act is accompanied by a descent and ascent of its muscular part, and in this way the capacity of the thoracic cavity is alternately increased and decreased in the vertical direction. The vault or cupola of the diaphragm is higher on the right side than upon the left side of the body. In forced expiration it rises on the right side as high as the upper margin of the fourth rib close to the sternum; whereas on the left side it only reaches the upper border of the fifth rib.

The *central portion* of the diaphragm is tendinous. From this the fleshy fibres will be observed to radiate and at the same time to arch downwards, so as to obtain attachment to the circumference of the lower aperture or outlet of the thorax. *In front*, it takes origin from the back of the lowest segment of the sternum; *behind*, it springs by two partly fleshy and partly tendinous processes called *the crura*, from the bodies of the upper three lumbar vertebræ, and upon each side of these from two ligamentous arches, termed the *ligamenta arcuata*; *laterally*, it arises from the lower six costal arches. Examine each of these attachments in turn.

Anterior Attachment.—The sternal origin consists of two slips which spring from the back of the xiphoid cartilage. These are separated from each other by

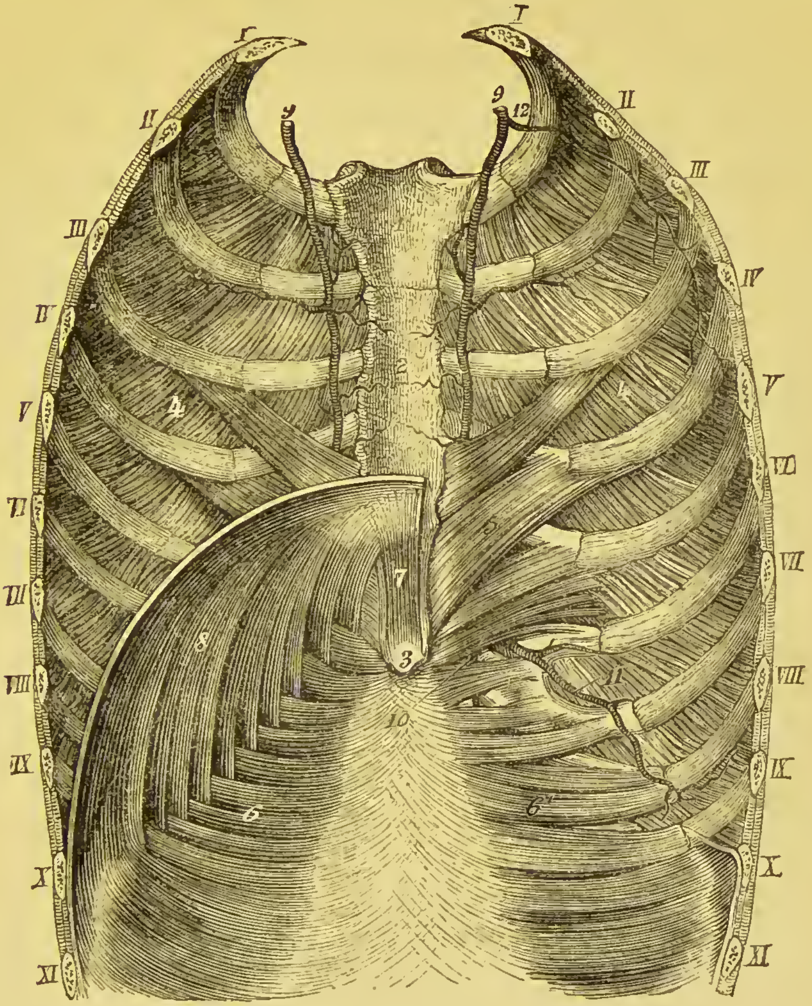


FIG. 34.

Posterior surface of the anterior wall of the thorax and abdomen, to show the costal and sternal origins of the diaphragm on the left side.—*From* LUSCHKA'S *Anatomy.*

(1) Manubrium sterni.
(2) Body of sternum.
(3) Ensiform cartilage.
(4) Internal intercostal muscles.
(5) Triangularis sterni.
(6) Transversalis abdominis.
(7) Sternal origin of diaphragm.
(8) Costal origin of diaphragm.
(9) Internal mammary artery.
(10) Superior epigastric artery.
(11) Musculo-phrenic artery.
(12) An occasional branch of the internal mammary.

a narrow linear interval filled by areolar tissue, and comparable with the wider interval in the mesial plane behind, which separates the two crura of the diaphragm.

The Lateral Attachment.—The costal origin consists of six pointed and fleshy slips which spring from the deep surfaces of the lower six costal cartilages. These interdigitate with the digitations of the transversalis abdominis. The sternal and costal origins of the diaphragm are separated by a small triangular interval, in which the pleural and peritoneal membranes are merely separated from each other by some loose areolar tissue. Through this gap the superior epigastric branch of the internal mammary artery descends into the abdominal wall.

The Posterior Attachment.—The *ligamentum arcuatum externum* is a fibrous band which stretches from the last rib to the transverse process of the first lumbar vertebra. It arches in front of the quadratus lumborum, and is merely the thickened upper part of the fascia which covers this muscle—*i.e.*, the anterior lamella of the lumbar fascia. By pressing the rib backwards the arch will be rendered more prominent. The *ligamentum arcuatum internum* arches over the psoas muscle, and, like the external ligament, is simply a thickening of the fascia which covers it. It is the stronger of the two, and is attached by one extremity to the tip of the transverse process of the first lumbar vertebra, and by the other to the body of the second lumbar vertebra and the tendinous part of the crus. Fleshy fibres arise from both of these arcuate bands; those from the internal ligament are more numerous and better marked than those which take origin from the external ligament, and they are continuous with the fleshy fibres of the crus. Very frequently a slight gap or interval exists between the fibres which spring from the ligamentum arcuatum externum and those which arise directly from the last rib. The anterior, lateral and posterior attachments of the diaphragm are therefore in this manner marked off from each other.

The *crura* of the diaphragm are two thick fleshy processes which descend upon the bodies of the upper lumbar vertebræ, tapering as they proceed downwards, and finally ending in pointed tendinous extremities. The *right crus* is the larger and longer of the two. It takes origin from the bodies of the upper three lumbar vertebræ, and the intervertebral discs which intervene between them. The *left crus* springs from the left side of the bodies of the first two lumbar vertebræ. It is much smaller, and lies upon a posterior plane to the right crus. Follow the crura upwards; opposite the last dorsal vertebra, they will be observed to be connected across the middle line by a strong fibrous band which arches over the aorta. From the upper border of this fibrous arch fleshy fibres arise which join both crura, and on this account some anatomists are inclined to classify it with the arcuate ligaments, and give it the name of *ligamentum arcuatum medium.**

Above this level the fleshy fibres of the crura

* It may be regarded as a universal law that wherever an artery pierces the origin or insertion of a muscle, and comes to lie between bone and muscular fibres, it is protected by a fibrous arch. Of this nature is the arch in question, and the fibrous arch thrown over the superior profunda artery on the back of the humerus, and the fibrous arches in the adductor magnus for the passage of the perforating arteries, and the femoral artery itself.

diverge and ascend to join the posterior border of the central tendon. The innermost fibres of each crus, however, decussate so as to separate the aortic from the œsophageal openings. The decussating fasciculus of the right crus is always the larger of the two, and moreover it usually passes in front of the decussating fasciculus of the left crus.

Central Tendon.—The central tendon is exceedingly strong. It is composed of strong tendinous bundles running in different directions, and closely woven together so as to give it a plaited appearance. This is well seen by an inspection of its abdominal surface. In shape the central tendon resembles a trefoil leaf, of which the right lobe is the largest, and the left lobe the smallest. Upon all sides it is surrounded by muscular fibres. Those which spring from the sternum are much the shortest.

Foramina of the Diaphragm.—The continuity of the diaphragm is broken by *three* large openings, and by some smaller apertures or fissures for the passage of the splanchnic nerves, and the vena azygos minor. The three main openings receive the names of the most important objects which they transmit. They are :—

(1.) The aortic.
(2.) The vena caval.
(3.) The œsophageal.

The *aortic opening* is in the mesial plane in front of the last dorsal vertebra, and between the crura of the diaphragm. It is bounded in front by the fibrous band which arches across the middle line and connects the tendinous portions of the two crura. Behind, a fibrous expansion is prolonged inwards, so as to limit the aperture posteriorly, and in this manner an almost complete fibrous ring is formed around the aorta.* The structures which pass through the aortic opening are—(1.) the aorta, (2.) the thoracic duct, and (3.) the vena azygos major—in this order from left to right.

The *vena caval opening* is at a higher level, being situated opposite the ninth dorsal vertebra, in front and slightly to the right of the aortic opening. Note that it is placed in the back part of the central tendon at the junction between its middle and right lobes. Its form is somewhat quadrangular, and its margins are prolonged upon the walls of the vena cava as it passes through it. The contraction of the muscular fibres of the diaphragm will therefore tend to increase the size of this opening and the calibre of the vein which it holds.

In addition to the vena cava, one or two minute twigs from the right phrenic nerve may be transmitted through the vena caval opening.

The *œsophageal opening* is an oval or elliptical foramen in the muscular part of the diaphragm. It lies in front and slightly to the left of the aortic aperture, and also at a higher level, being placed opposite the lower border of the body of the ninth

* On the left side the fibrous expansion which passes inwards behind the aorta is often absent. On both sides it is attached to the anterior aspect of the body of the last dorsal vertebra.

dorsal vertebra. In some cases its anterior border is tendinous, and formed by the posterior margin of the central tendon. Posteriorly it is separated from the aortic opening by the decussation of the internal fibres of the crura.

The œsophageal opening transmits the gullet and the two pneumogastric nerves.

The three large openings of the diaphragm are therefore very different in their features. *The aortic opening* is a fibrous ring behind the diaphragm, and it can in no way be affected by the contraction of the muscular fibres. The *vena caval opening* is in the central tendon, and its margins are attached to the wall of the vessel which it transmits ; contraction of the diaphragm must therefore have a tendency to widen this aperture. The *œsophageal opening* is placed in the muscular part, and consequently it is highly probable that the fibres which surround it may be capable of exercising a constricting influence upon the œsophagus, and in this way help to prevent regurgitation of food during the descent of the diaphragm.

Little need be said regarding the smaller foramina. Each crus is pierced by the *three splanchnic nerves*, and the left crus is likewise perforated by the *vena azygos minor*. Keep in mind also that the *superior epigastric* artery descends in the interval between the sternal and costal attachments of the diaphragm, and that the *musculo-phrenic* artery pierces the costal attachment opposite the eighth or ninth rib.

Relations of the Diaphragm.—The viscera, in relation to its upper and lower surfaces, have been already pointed out (p. 122). The abdominal surface of the diaphragm is almost completely clothed by peritoneum. The only part of any extent left uncovered is that portion which is in relation to the bare area on the posterior border of the liver. The thoracic surface is clothed in the middle by the fibrous pericardium, and on each side by the pleura. A limited portion of the circumference, however, is bare, and this in apposition anteriorly with the triangularis sterni muscle, and laterally with the internal intercostal muscles and costal arches.

The Nerves and Blood-Vessels of the Diaphragm.—The diaphragm draws its arterial and nervous supply from the following sources, viz.:—

Nerves.
- (1.) The phrenic nerves.
- (2.) Twigs from the lower five or six intercostal nerves.
- (3.) The diaphragmatic plexuses, offshoots from the solar plexuses.

Arteries.
- (1.) The inferior phrenic arteries.
- (2.) The accompanying arteries of the phrenic nerves.
- (3.) The musculo-phrenic arteries.
- (4.) Twigs from the lower intercostal arteries.
- (5.) Twigs from the upper lumbar arteries.

Vessels on the Posterior Wall of the Abdomen.

The abdominal aorta and its branches and the vena cava must now be cleaned. In doing this, care should be taken of the gangliated cord of the sympathetic which extends downwards on each side of the vertebral column. It is necessary to bear in mind that the lumbar branches of the aorta as they proceed outwards pass *behind* this. Separate the right crus of the diaphragm from the aorta, and dissect in the interval between them. Here the *receptaculum chyli* and the *vena azygos major* will be found. A chain of lymphatic glands, termed the *lumbar glands*, will be noticed in relation to the aorta. The only branches of the aorta which are liable to injury are the *spermatic arteries.* These are two slender arteries which spring from the front of the vessel a short distance below the renal arteries. They are so small that they are apt to be overlooked.

The Abdominal Aorta.—The abdominal aorta is the direct continuation of the thoracic aorta, and enters the abdomen through the aortic opening of the diaphragm. It begins in the mesial plane in front of the last dorsal vertebra, and it ends upon the left side of the body of the fourth lumbar vertebra by dividing into the two *common iliacs.* It therefore pursues an oblique course—slightly inclining to the left as it proceeds downwards. A line drawn between the highest points of the iliac crests would indicate the level of the bifurcation of the abdominal aorta; it takes place opposite the left side of the umbilicus.

Most of the structures which lie *in front* of the abdominal aorta have been removed. In immediate relation to it from above downwards are :—(1.) The solar plexus and the ascending layer of the transverse meso-colon. (2.) The pancreas and splenic vein. (3.) The third part of the duodenum and the left renal vein. (4.) The peritoneum and the aortic plexus of nerves. Superficial to these it is covered by the gastro-hepatic omentum and the stomach, the transverse colon and its mesentery, and by the great omentum, and the coils of the small intestine. *Behind*, the abdominal aorta rests upon the bodies of the lumbar vertebræ and the intervertebral discs, separated from them, however, by the anterior common ligament and the left lumbar veins. *On each side* it is related in its upper part to the crus of the diaphragm. On the *right side* the vena cava lies close to the aorta as high as the second lumbar vertebra, but above this it is separated from it by the fleshy part of the right crus. In the interval between the right crus of the diaphragm and the vessel the student has already noted the receptaculum chyli and the vena azygos major. On the *left side*, the left gangliated cord of the sympathetic is in relation to the artery below the level of the left crus.

Branches of the Abdominal Aorta.—The branches of the abdominal aorta may be described under two heads, viz.—(1.) Those which come off *in pairs*. (2.) Those which arise *singly*.

Paired Branches.	Single Branches.
(1.) Inferior phrenic arteries.	(1.) The cœliac axis.
(2.) Middle capsular arteries.	(2.) The superior mesenteric.
(3.) Renal arteries.	(3.) The inferior mesenteric.
(4.) Spermatic or ovarian arteries.	(4.) The middle sacral.
(5.) Lumbar arteries.	

The *single branches* have already been described with the exception of the *middle sacral*, which arises from the extremity of the aorta between the two common iliacs. It will be studied in connection with the pelvis. The *paired branches* may now be examined.

The Inferior Phrenic Arteries have already been noticed upon the under surface of the diaphragm. They are two in number, and are the first branches of the abdominal aorta. Diverging from each other, the artery of the right side passes behind the vena cava, whilst the artery of the left side goes behind the œsophagus. At the posterior border of the central tendon of the diaphragm, each divides into an *external* and *internal* branch. The *external branch* proceeds outwards to anastomose with the intercostal arteries, whilst the *internal branch* curves forwards in front of the central tendon, and ends by anastomosing with its fellow, and with the internal mammary artery.

Each phrenic artery, in addition to the branches which it supplies to the diaphragm, gives a twig, called the *superior capsular artery*, to the suprarenal body. On the left side it also sends a few minute branches to the œsophagus.

The *phrenic veins* open into the vena cava.

The Middle Capsular Arteries are two small vessels which arise one from each side of the aorta at the same level as the superior mesenteric. They run outwards and upwards in front of the crura of the diaphragm to the suprarenal bodies, into the substance of which they sink. On the right side the middle capsular artery passes behind the vena cava. They anastomose freely with the superior and inferior capsular arteries.

The *right capsular vein* opens into the vena cava, whilst the *left vein* ends in the renal or phrenic vein.

The Renal Arteries, when compared with the organs which they supply, are disproportionately large. Only a small part of the blood which they carry to the kidneys is used for the nourishing of the gland substance. The kidneys are the great excretory organs for the waste nitrogenous materials of the body, and it is necessary that the blood should pass to them in large quantity in order that it may be purified.

The renal arteries take origin about a quarter of an inch below the superior mesenteric. Each artery proceeds outwards at right angles to the aorta, and, approaching the kidney, breaks up into four or five branches, which enter the hilus. It is overlapped by the accompanying vein. Seeing that the aorta lies a little to the left of the mesial plane, the right renal artery is the longer of the two; the right artery also passes behind the vena cava. Again examine the relation of parts at the hilus. From before backwards we find :—

(1.) Veins.
(2.) Arteries.
(3.) Ureter.

The renal artery gives a small twig—*the inferior capsular*—to the suprarenal body.

The *renal veins* join the vena cava. The vein of the left side crosses in front of the aorta, and is the longer of the two. Both receive twigs from the supra-renal bodies, and the left vein is also joined by the left spermatic or ovarian vein.

The Spermatic Arteries are two long slender vessels which spring from the front of the abdominal aorta a short way below the renal arteries. Diverging from each other, each artery passes obliquely downwards and outwards behind the peritoneum, to the internal abdominal ring where it joins the other factors of the spermatic cord. As it descends it rests upon the psoas, and crosses the ureter and the external iliac artery. On the right side, the spermatic artery passes in front of the vena cava inferior.

In the female the corresponding arteries go to the ovaries and uterus, and are consequently termed *the ovarian*. Within the abdomen proper they have the same relations as the spermatic arteries. In the dissection of the female pelvis they will be followed to their destination.

The *right spermatic vein* joins the vena cava directly, whilst the *left vein* terminates in the left renal vein. The *ovarian veins* end in the same manner.

The Lumbar Arteries—four in number on each side—spring from the posterior aspect of the abdominal aorta, in series with the intercostal arteries. At present they are only seen in a very short part of their course. They proceed outwards upon the bodies of the vertebræ, behind the gangliated cord of the sympathetic, and then disappear under the cover of the psoas muscle. The two upper arteries also pass behind the crura of the diaphragm and on the right side they are crossed by the inferior vena cava.

The *lumbar veins* join the inferior vena cava, and those of the left side pass behind the aorta.

Vena Cava Inferior.—This is the large vein which collects, by means of its tributaries, the venous blood from the lower limbs, the abdominal viscera, and a great part of the abdominal parietes. It is formed on the right side of the body of the fifth lumbar vertebra by the union of the two *common iliac* veins. As it ascends, it lies in the first place upon the vertebral column, close to the right side of the aorta; above the level of the second lumbar vertebra it lies upon the fleshy part of the right crus of the diaphragm which intervenes between it and the aorta; lastly, it is contained in a deep groove, in the posterior border of the liver, and turning forwards leaves the abdomen by passing through the vena caval opening of the diaphragm, to open into the right auricle of the heart.

As it passes upwards it has already been seen to receive the following tributaries:—

(1.) The common iliac veins.
(2.) The middle sacral vein.
(3.) The lumbar veins.
(4.) The right spermatic or ovarian vein.
(5.) The renal veins.
(6.) The right middle capsular vein.
(7.) The inferior phrenic veins.
(8.) The hepatic veins.

The Common Iliac Arteries.—The two terminal branches of the aorta should next be examined. They arise upon the left side of the body of fourth lumbar vertebra and, diverging from each other, proceed downwards and outwards upon the vertebral column. After a course of about two inches, each vessel ends opposite the lumbo-sacral articulation by dividing into the *external* and *internal iliac* arteries; of these the former is the larger of the two and appears to be the continuation of the parent trunk, whilst the latter passes downwards into the pelvis.

The common iliac artery of each side is covered by peritoneum, and overlapped by coils of the small intestine; furthermore, it is crossed by the large sympathetic twigs which connect the aortic and hypogastric plexuses and, close to its termination, by the ureter. But the artery of the left side has other structures in relation to it anteriorly—viz., the rectum and the superior hæmorrhoidal artery, both of which pass down in front of it.

The position of the corresponding veins should be carefully noted. This differs on the two sides of the body. The *left common iliac vein* is in relation to both arteries. It first lies along the *inner* or *right* side of its companion artery, and then crosses *behind* the upper part of the right artery to reach the vena cava inferior. The *right common iliac vein* at first lies behind its companion artery, but, as it ascends, it gradually comes to lie upon its right side, and here it joins the vena cava.

No collateral branches of any consequence proceed from the common iliac artery.

The External Iliac Artery is the first or abdominal portion of the great arterial trunk which carries blood to the lower limb. It begins, as we have seen, opposite the lumbo-sacral articulation, and extends obliquely downwards and outwards along the brim of the true pelvis to Poupart's ligament, behind which it passes into the thigh, and becomes the *femoral artery.* Its course can be indicated on the surface with tolerable accuracy by drawing a line from the left side of the umbilicus to a point midway between the symphysis pubis and the anterior superior spine of the ilium.

Like the common iliac artery, the external iliac is closely covered by peritoneum and overlapped by coils of the small intestine. Towards its termination it is crossed by an artery, a vein, and a minute nerve—viz., the spermatic artery, the deep circumflex iliac vein, and the genital branch of the genito-crural nerve. *Posteriorly,* it rests upon the inner margin of the psoas muscle, separated from it, however, by the iliac fascia, to which it is bound down by a condensed part of the extra-peritoneal tissue, which passes over it. The genito-crural nerve lies along the *outer side* of the artery, and the companion vein is placed on its *inner side;* on the right side, however, the vein, as it passes upwards, gradually comes to lie behind the artery.

The external iliac gives off two large branches to the abdominal wall, viz. :—

(1.) The deep epigastric.
(2.) The deep circumflex iliac.

They arise close to Poupart's ligament, and have both been examined (pp. 90, 92). The veins corresponding to these arteries open into the external iliac vein.

Deep Lymphatic Glands.—The dissector has, doubtless, noticed a chain of lymphatic glands in connection with the external iliac artery, the common iliac artery, and also extending upwards upon the vertebral column in relation to the aorta and vena cava. The *external iliac glands* receive the efferent vessels which proceed from the inguinal glands. As we proceed upwards, the vessels which connect the various glands become greatly diminished in number but much increased in calibre, until at last they resolve themselves into four or five large lymphatic trunks, which join the lower part of the receptaculum chyli.

Receptaculum Chyli.—This is the dilated commencement of the thoracic duct. It is placed upon the body of the second lumbar vertebra, in the interval between the right crus of the diaphragm and the aorta. To bring it into view, it may be necessary to separate the right crus from the lumbar vertebræ and pull it aside. When fully displayed, the receptaculum chyli is seen to be a narrow elongated sac about an inch in length, which receives by its lower end several large lymphatic vessels, whilst superiorly, it contracts and becomes the thoracic duct. At its upper end it is joined anteriorly by the lacteal vessels. The vena azygos major lies along its right side, but the receptaculum chyli is easily distinguished from this by the whiteness of its walls. The thoracic duct enters the thorax by passing through the aortic opening of the diaphragm (p. 201).

Azygos Veins.—The *right azygos* vein or *vena azygos major* usually takes origin by a small branch from one of the right lumbar veins, but in some cases it arises by a twig from the right renal vein or even from the vena cava. It will be found in the interval between the right crus of the diaphragm and the aorta, upon the right side of the receptaculum chyli, and it will be noticed to enter the thorax by passing through the aortic opening of the diaphragm.

The *vena azygos minor inferior* is more difficult to discover. It originates on the left side of the spine, in a small twig from one of the left lumbar veins, or perhaps from the left renal vein, and enters the thorax by piercing the left crus of the diaphragm.

Fascia and Muscles on the Posterior Wall of the Abdomen.

The muscles on the posterior wall of the abdomen are three in number—viz. (1.) The *psoas*, an elongated fleshy mass extending downwards on the side of the spine; (2.) The *quadratus lumborum*, a quadrate muscle external to the psoas, and stretching between the crest of the ilium and the last rib; (3.) The *iliacus*, situated in the iliac fossa. The fascia which covers these muscles must, in the first place, be studied.

Quadratus Lumborum Fascia.—Follow this inwards and it will be found to be attached to the anterior aspect of the roots of the transverse processes of the lumbar vertebræ. Trace it outwards and it will be noticed to join the posterior aponeurosis of the transversalis abdominis muscle. From these connections the dissector will understand that this fascia is simply the anterior lamella of the lumbar fascia. But what are its superior and inferior attachments? Above, it is fixed to the last rib, and is thickened so as to form the *ligamentum arcuatum externum;* whilst inferiorly, it is attached to the ilio-lumbar ligament. The quadratus lumborum muscle, therefore, is enclosed in a sheath formed anteriorly by the anterior lamella of the lumbar fascia, and posteriorly by the middle lamella of the lumbar fascia (Fig. 10, p. 77).

The Fascia covering the Psoas and Iliacus is one continuous aponeurotic sheet. *Above* the level of the crest of the ilium, where it is merely in relation to the psoas, it is thin and narrow. Here it is attached externally to the fascia covering the quadratus lumborum, whilst internally it is fixed to the spine by a series of fibrous arches which bridge over the lumbar arteries. Superiorly, it has been seen to form the thickened band termed the *ligamentum arcuatum internum. Below*, the fascia expands so as to cover both the psoas and the iliacus, and, at the same time, it becomes much denser and thicker. Here it receives the name of the *fascia iliaca*, and presents most important connections. The external iliac vessels lie upon it, whilst the anterior crural nerve lies behind it. The genito-crural nerve pierces it, and comes into relation with the external iliac artery. Externally it is firmly fixed to the crest of the ilium, whilst internally it sweeps over the psoas, and is attached to the brim of the true pelvis. These attachments can be easily demonstrated by dividing it in the vertical direction, over the iliacus, a short way to the outer side of the psoas. It is very loosely attached to the subjacent muscles, so that the fingers can readily be passed behind it, first in an outward and then in an inward direction. Note that no perceptible fascial partition dips backwards from it between the psoas and iliacus.

The inferior connections of this fascia have already been studied (p. 108). On the outer side of the iliac vessels it has been seen to become continuous with the fascia transversalis, and, at the same time, to be attached to Poupart's ligament; whilst behind these vessels it is carried downwards into the thigh, to form the posterior wall of the femoral sheath.

Dissection.—The muscles should now be cleaned and their attachments defined; but, in doing this, certain points must be attended to. The inner portion of the fascia iliaca must be carefully preserved, in order that its relation to the pelvic fascia may be afterwards made out. In the case of the *psoas muscle*, great care must be taken not to injure—(1.) the sympathetic cord, which lies along its inner margin; (2.) the genito-crural nerve, which runs downwards in front of it; (3.) the ilio-hypogastric, the ilio-inguinal, and the external cutaneous nerves, which appear at its outer border, and the anterior crural nerve, which lies in the interval between it and the iliacus muscle. In the case of the *quadratus lumborum*, bear in mind that the last dorsal nerve runs outwards in front of this muscle, close to the lower border of the last rib, and that the ilio-hypogastric and ilio-inguinal nerves cross it obliquely at a lower level.

Quadratus Lumborum.—This muscle *arises* from the ilio-lumbar ligament and from the crest of the ilium behind it. Narrowing slightly as it passes upwards, it is *inserted* into the inner half of the last rib, behind the ligamentum arcuatum externum, and by four tendinous slips into the tips of the transverse processes of the four upper lumbar vertebræ.

The Psoas Magnus.—This muscle has three distinct modes of origin from the side of the vertebral column:—(1.) by five fleshy processes from the anterior surfaces and lower borders of the transverse processes of the lumbar vertebræ close to their roots; (2.) by five slips, each of which arises from the intervertebral disc and the contiguous margins of the bodies of two vertebræ—the first slip springing from the last dorsal and the first lumbar vertebra and the intervening disc, and that last slip from the two lower lumbar vertebræ and their intervening disc; (3.) from four tendinous arches which bridge across the four lumbar arteries and protect these vessels from the pressure of the contracting muscle.

The psoas tapers somewhat as it extends downwards along the brim of the pelvis, and a tendon appears on its outer border, which affords attachment to the fibres of the iliacus. Passing behind Poupart's ligament, it is inserted into the small trochanter of the femur.*

The Iliacus.—This muscle arises from the iliac fossa, the ilio-lumbar ligament, the base of the sacrum, and the capsule of the hip joint. It is inserted into the tendon of the psoas magnus—it going to be inserted into the small trochanter. Some of its fibres, however, have a separate insertion into an impression below the small trochanter of the femur.

Nerves on the Posterior Wall of the Abdomen.

The nerves on the posterior wall of the abdomen are the gangliated cord of the sympathetic and the anterior primary divisions of the spinal nerves, with the branches which proceed from them. These should now be dissected.

Gangliated Cord of the Sympathetic.—This enters the abdomen behind the ligamentum arcuatum internum, and extends downwards upon the bodies of the lumbar vertebræ along the inner border of the psoas muscle. *Above* it is continuous with the thoracic portion of the cord, whilst *below* it passes behind the common iliac artery and enters the pelvis. In the thorax it is placed upon the heads of the ribs;

* Another muscle, called the *psoas parvus*, is occasionally present. This springs from the bodies of the last dorsal and first lumbar vertebræ, and the intervertebral disc between them, and stretching downwards upon the anterior and inner aspect of the psoas magnus, it ends in a tendon which is inserted into the ilio-pectineal eminence and ilio-pectineal line.

here, however, it lies nearer the middle line, being carried forward by the psoas muscle. On the right side, it is in great part covered by the vena cava, and on both sides the lumbar vessels pass outwards behind it. As a general rule, a small oval ganglion is formed upon the body of each lumbar vertebra. An *external* and an *internal* series of branches will be observed to spring from these ganglia.

The *external branches* connect the ganglia with the anterior primary divisions of the lumbar spinal nerves. Two will be found accompanying each lumbar artery. Trace them carefully backwards by cutting through the fibrous arches which bridge over these vessels, and scraping away the fibres of the psoas muscle. They join the lumbar nerves close to the intervertebral foramina.

The *internal branches* are chiefly given to the aortic plexus, but some will be found passing downwards in front of the common iliac artery to join the hypogastric plexus. Several twigs are also given to the vertebræ and their ligaments.

Lumbar Nerves.—To bring the anterior primary branches of the lumbar nerves into view, it is necessary to scrape away the psoas muscle. This has already been partially effected in following the connecting sympathetic twigs backwards. An occasional branch, the *accessory obturator*, is very liable to injury unless it be secured at once. When present it will be found descending along the inner border of the psoas.

The *anterior primary divisions of the lumbar nerves* are five in number, and pass outwards in the substance of the psoas muscle. They increase in size from above downwards, and each nerve is joined by two twigs from the sympathetic cord. Branches are given by them to the psoas and quadratus lumborum muscles.

The first *three* lumbar nerves, with a part of the *fourth* unite in a loop-like manner to form the *lumbar plexus*, whilst the remaining part of the *fourth* joins the *fifth* to form the *lumbo-sacral cord.*

Lumbar Plexus.—This plexus is placed in front of the transverse processes of the lumbar vertebræ in the substance of the psoas. *Above* it is usually connected with the last dorsal nerve by a small twig which descends in the substance of the quadratus lumborum to the first lumbar nerve; *below* it is brought into communication with the sacral plexus by the branch of the fourth nerve, which enters into the formation of the lumbo-sacral cord.

The following are the branches which proceed from the lumbar plexus :—

(1.) Ilio-hypogastric, (2.) Ilio-inguinal,	derived from	1st lumbar nerve.
(3.) Genito-crural,	,,	1st and 2nd lumbar nerves.
(4.) External cutaneous,	,,	2nd and 3rd lumbar nerves.
(5.) Anterior crural,	,,	2nd, 3rd and 4th lumbar nerves.
(6.) Obturator,	,,	3rd and 4th lumbar nerves.

The *ilio-hypogastric nerve* emerges from the outer border of the psoas, and crosses the quadratus lumborum obliquely. Reaching the crest of the ilium, it leaves the abdomen by piercing the transversalis muscle. Its further course has already been studied (p. 76). It is distributed by an *iliac* branch to the skin of the gluteal region, and by a *hypogastric* branch to the skin over the lower part of the abdominal wall.

The *ilio-inguinal nerve* is smaller than the ilio-hypogastric, and leaves the psoas almost at the same point. It runs obliquely downwards and outwards over the quadratus lumborum and the upper part of the iliacus, and disappears from view by piercing the transversalis muscle a little way in front of the ilio-hypogastric. It is distributed to the integument of the scrotum and the inner aspect of the thigh (p. 76).

The *genito-crural nerve* is directed forwards through the psoas, and appearing upon its anterior aspect, ends by dividing into a genital and a crural branch. The *genital branch* proceeds downwards and inwards, and crossing the external iliac artery, reaches the internal abdominal ring. Here it joins the other constituents of the spermatic cord, and leaving the abdomen, is distributed to the cremaster muscle. In the female it ends in the round ligament of the uterus and the labium pudendi. The *crural branch* runs downwards along the outer side of the external iliac artery, and crossing the deep circumflex iliac artery, passes behind Poupart's ligament. It supplies a limited portion of the integument in front of the thigh.

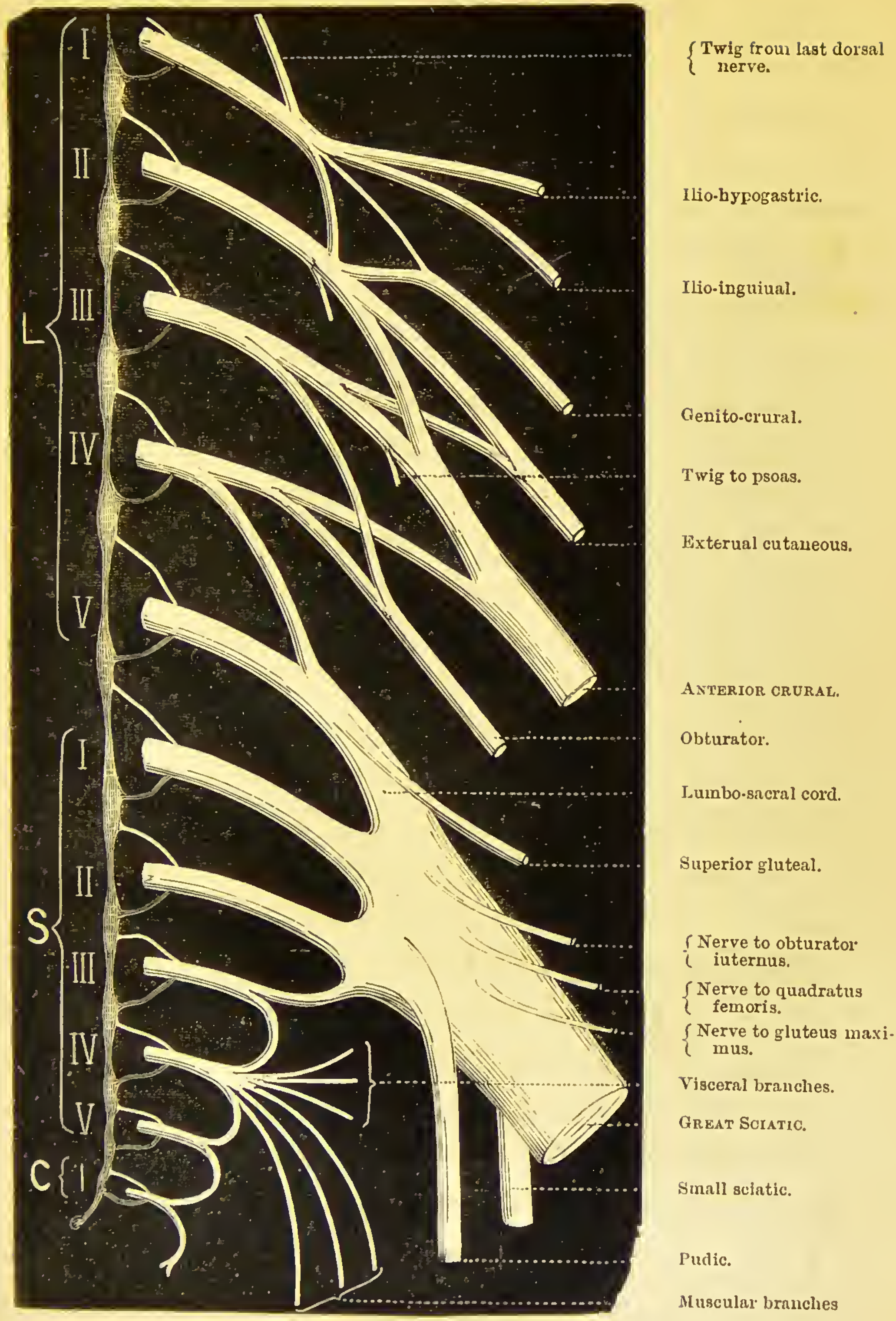


FIG. 35.
Diagram of the lumbar and sacral plexuses.

The *external cutaneous nerve* of the thigh emerges from the outer border of the psoas about its middle, and descends obliquely across the iliacus muscle to the anterior superior spine of the ilium. At this point it leaves the abdomen by passing behind Poupart's ligament. It supplies the skin upon the outer aspect of the thigh.

The *anterior crural nerve* is the largest branch of the plexus. It runs downwards in the interval between the psoas and iliacus, and passes from the abdomen behind Poupart's ligament. It will be observed to give twigs to the iliacus muscle, and a branch to the upper part of the femoral artery.

The *obturator nerve* emerges from the inner border of the psoas, and extends forwards upon the inner wall of the pelvis a short way below the brim. At the upper part of the thyroid foramen it joins the artery of the same name, and escaping from the pelvis, enters the thigh.*

Lumbo-sacral Cord.—This large nervous trunk is formed by the union of the anterior primary division of the fifth lumbar nerve with a branch from the fourth lumbar nerve. It passes downwards over the base of the sacrum into the pelvis, joins the sacral plexus, and gives off the *superior gluteal* nerve.

* A small nerve, the *accessory obturator*, is occasionally to be found. It may either spring directly from the obturator or from the third and fourth lumbar nerves. It proceeds downwards along the inner side of the psoas, and it enters the thigh by passing over the pubic bone under cover of the pectineus. Here it gives branches to the hip joint and to the pectineus, and communicates with the obturator nerve.

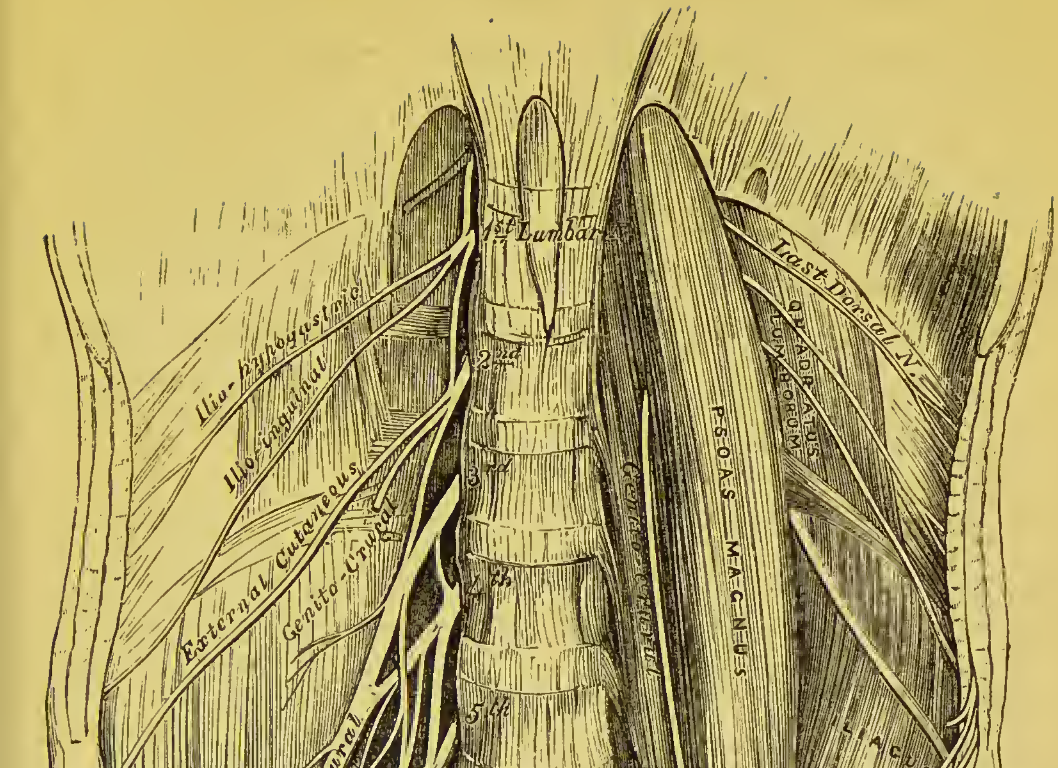


FIG. 36.

Lumbar and sacral plexuses.—*From* GRAY'S *Anatomy*.

The Last Dorsal Nerve will be found running outwards in front of the quadratus lumborum, along the lower border of the last rib. Near the spine it sends a small offset downwards to the first lumbar nerve, and at the outer border of the quadratus lumborum it pierces the aponeurosis of the transversalis abdominis, and then passes forwards between this muscle and the internal oblique. Its course and distribution in the wall of the abdomen have already been described (pp. 58, 76).

Lumbar Arteries.—These have been traced to the inner border of the psoas. They are now observed to pass backwards behind this muscle to the intervals between the transverse processes of the lumbar vertebræ. Here each ends by dividing into a dorsal and an abdominal branch.

The *dorsal branch* runs backwards between the transverse processes, and after giving a *spinal* branch, which enters the spinal canal through the intervertebral foramen, ends in the muscles and integument of the back.

The *abdominal branches* proceed outwards behind the quadratus lumborum, and are then directed forwards between the abdominal muscles, where they anastomose, above with the intercostal arteries, below with the deep circumflex iliac and ilio-lumbar arteries, and in front with the superior and deep epigastric arteries.

Dissection.—The lower limbs having, by this time, been removed from the trunk, the pelvis may also be detached. Place a ligature around the aorta and vena cava at the bifurcation of the former, and divide them immediately above this point. Then carry the knife through the intervertebral disc which intervenes between the third and fourth lumbar vertebræ, and, having cut the nerves and soft parts, complete the separation of the pelvis from the remainder of the trunk by means of the saw.

PELVIS. V

The pelvis is the basin-shaped lower part of the abdominal cavity. It has already been defined as being that portion of the general cavity of the abdomen which lies below the level of the ilio-pectineal lines of the innominate bones. Its walls are, for the most part, rigid and composed of bone; *behind*, it is bounded by the sacrum and coccyx; whilst, *in front* and *laterally*, it is bounded by the two ossa innominata. The bony wall, however, is deficient at certain points; thus *posteriorly*, there is an interval on each side, between the sacrum and the os innominatum, which is partially filled up by the sacro-sciatic ligaments; again, *laterally*, there is the wide thyroid foramen, which is closed by the thyroid membrane; and, *in front*, there is the gap left by the pubic arch, which is occupied by the triangular ligament of the urethra.*

Upon the inner aspect of these boundaries of the

*Let it be clearly understood that it is the so-called "anterior layer" of the triangular ligament to which we refer, and not the "posterior layer."

pelvis there are placed certain muscles. *Posteriorly*, upon the anterior aspect of the sacrum, are the *pyriformes* muscles; *laterally*, upon the inner aspect of the innominate bone, is the *obturator internus;* whilst, *in front*, lying against the posterior surface of the triangular ligament, is the *compressor urethræ* muscle. But, in addition, there is a strong aponeurotic membrane, called the parietal layer of the pelvic fascia, which forms a complete lining for the pelvis, and is placed upon the deep surface of these muscles.

The pelvic wall may therefore be regarded as consisting of three strata, each composed of parts which lie in the same morphological plane, viz. :—

(1.) A bony, ligamentous, and membranous stratum.*
(2.) A muscular stratum.
(3.) An aponeurotic stratum.

Inferiorly, the pelvic cavity is closed and marked off from the perineum by the visceral layer of the pelvic fascia, which passes inwards to the viscera from the parietal layer of the same aponeurosis, and also by the pelvic diaphragm, which is placed upon the under surface of the fascia. As we have already seen, this diaphragm consists of the two levatores ani muscles and the two coccygei muscles. *Superiorly*, the pelvic and abdominal cavities are directly continuous.

The contents of the pelvic cavity differ in the two

* There are animals in which the sciatic ligaments are bony; and the author has seen a female pelvis in the dissecting rooms with the same ligaments in similar condition.

sexes; in both, however, the bladder occupies the fore-part, and the rectum the back part of the space. The difference is to be found in the generative organs. It is necessary, therefore, to describe the male and female pelvis separately.

MALE PELVIS.

Within the male pelvis we find the following structures:—

Viscera.
- (1.) The rectum.
- (2.) The bladder, with the lower portion of the ureters, the prostate, and the prostatic portion of the urethra.
- (3.) Vasa deferentia and the vesiculæ seminales.

Blood-vessels.
- (1.) The internal iliac vessels and their branches.
- (2.) The superior hæmorrhoidal vessels.
- (3.) The middle sacral vessels.
- (4.) Certain venous plexuses in connection with the viscera.

Nerves.
- (1.) The sacral plexuses and their branches.
- (2.) The obturator nerves.
- (3.) The pelvic part of the sympathetic.

Sacro-Coccygeal Nerves.

The peritoneum dips into the pelvis, and gives a partial covering to the rectum and the bladder.

General Position of Viscera.—The *rectum* occupies the posterior part of the cavity. It takes a curved course downwards upon the sacrum and coccyx, to the concavity of which it is adapted. The *bladder* is placed in the fore-part of the cavity, and lies against the pubic bones. Behind the bladder, between it and the rectum, are the *vesiculæ seminales* and the *vasa deferentia*, whilst embracing its neck is the *prostate.* At present, however, the bladder and the rectum are the only viscera visible.

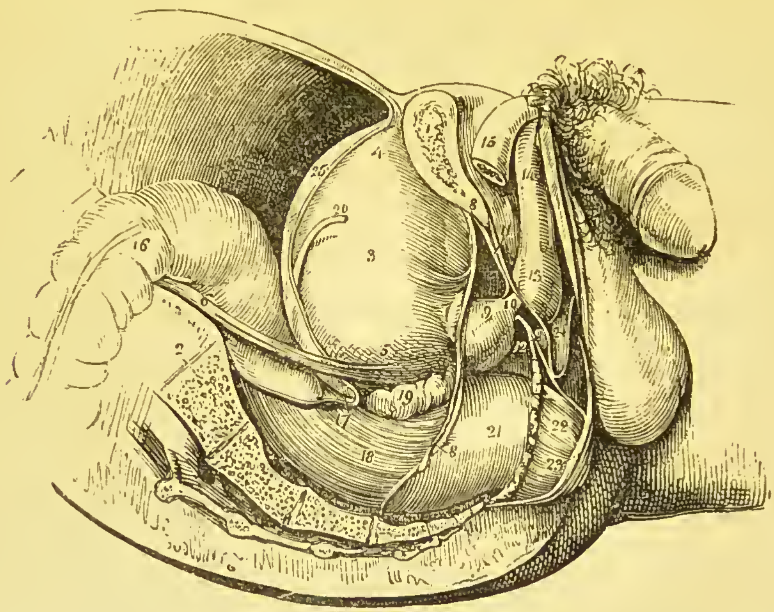


FIG. 37.

Side view of pelvic viscera. Subject in the horizontal position.
—*From* WILSON'S *Anatomy.*

(1) Section of pubic bone.
(2) Section of sacrum and coccyx.
(3) Bladder.
(4) Summit of bladder.
(5) Base of bladder.
(6) Ureter.
(7) Neck of bladder.
(8) Visceral pelvic fascia.
(9) Prostate.
(10) Membranous portion of urethra.
(11) Parietal pelvic fascia.
(12) Cowper's gland.
(13) Bulb of penis.
(14) Corpus spongiosum.
(15) Right crus of penis.
(16) Rectum (first part).
(17) Recto-vesical pouch of peritoneum.
(18) Rectum (second part).
(19) Right seminal vesicle.
(20) Right vas deferens.
(21) Pelvic fascia covering rectum.
(22) Third part of rectum, clothed by the levator ani.
(23) Sphincter ani externus.
(24) Interval between the triangular ligament and the superficial fascia of the perineum.

Peritoneum.—The peritoneum is continued from the posterior wall of the abdomen into the pelvis. Here it comes into relation with the rectum, to which it gives a partial covering. The first part of the rectum it invests completely, and connects by means of a fold called the *meso-rectum* to the anterior surface of the sacrum. Gradually it leaves the gut, first disappearing from its posterior surface, then from its lateral, and finally from its anterior surface, and passes on to the lower and back part of the bladder. The point at which the peritoneum departs from the rectum may be stated to be about three inches above the anus, or, in other words, along a line connecting the middle points of the two vesiculæ seminales—somewhat less than an inch from the base of the prostate. This is a point, however, which is subject to much variation. It is affected by the full or empty condition of the bladder or rectum. When either viscus is distended, the peritoneum rises with it, and the line of reflection is placed at a greater distance from the prostate. But, again, it is not uncommon to find the peritoneum passing lower down; and, in rare instances, it may even reach the base of the prostate before it is continued on to the bladder.

The peritoneum now ascends upon the back of the bladder, and reaching the summit, is conducted from it by the urachus on to the posterior aspect of the anterior abdominal wall. On each side of the viscus it extends outwards as far as the obliterated hypogastric artery, along the line of which it quits the bladder, and is continued round the pelvic wall.

Recto-vesical Pouch.—As the peritoneum passes from the posterior wall of the pelvis to the back of the bladder, it is raised in the form of two semi-lunar and horizontal ridges or folds by the obliterated hypogastric arteries. These folds extend forwards one on each side of the rectum, and they limit laterally a deep peritoneal pouch or recess between the rectum and bladder, which, from its position, is called the *recto-vesical pouch.*

False Ligaments of the Bladder.—Wherever the peritoneum leaves the bladder to reach the pelvic or abdominal wall, it is termed "a false ligament." Of these, *five* are described—viz., two posterior, two lateral, and one superior.

The *posterior false ligaments*, or *recto-vesical folds*, are the two semi-lunar folds which limit the recto-vesical pouch laterally. They are produced, as we have seen, by the peritoneum being stretched over the obliterated hypogastric artery as it passes forwards to reach the bladder. Within each of these folds future dissection will reveal, in addition to the impervious hypogastric artery, the ureter and the superior vesical artery accompanied by some minute nerves.

The *lateral false ligament* is the name given to the peritoneum as it passes from each side of the bladder to the wall of the pelvis and the iliac fossa. This reflection has been seen to take place along the line of the obliterated hypogastric artery as it lies upon the lateral aspect of the bladder.

The *superior false ligament* is the portion of peritoneum which is continued from the summit of the bladder on to the posterior aspect of the anterior abdominal wall. It is led away from the viscus by the urachus and the two obliterated hypogastric arteries.

Hypogastric Nervous Plexus.—This is the lowest of the three great prevertebral plexuses, and is the main source from which the pelvic viscera are supplied with nerves. It is an exceedingly dense plexus, which lies in front of the body of the last lumbar vertebra in the interval between the two common iliac arteries. *Superiorly*, it is joined by numerous large filaments, which proceed downwards from the aortic plexus and the lumbar ganglia. *Inferiorly*, it will afterwards be seen to end by dividing into two lateral parts termed the *pelvic plexuses*, but these must not be followed out at present.

Pelvic Fascia.—Now is the time to study the pelvic fascia, and it is a work which will require some care and patience on the part of the dissector. Much of the difficulty which involves the study of the pelvic fascia will be removed if the student will constantly keep before him two facts regarding it, viz.—(1.) That it constitutes a lining for the inner surface of the entire pelvic wall. (2.) That it sends across the pelvic cavity a layer which acts as a partition between the pelvis proper and the perineum. The lining portion of the fascia may be termed the *parietal part*, and the partition portion the *visceral part*. If the pelvis contained no viscera, the arrangement would be exceedingly simple, and might be represented diagrammatically thus :—

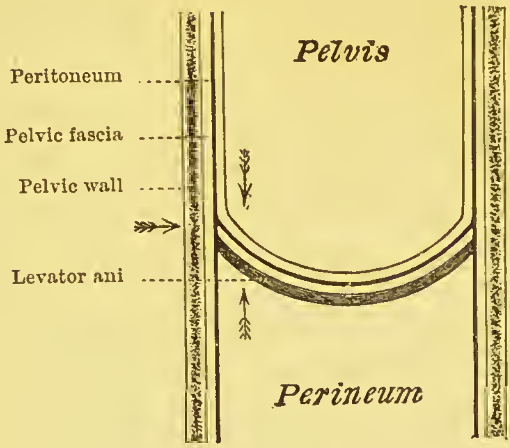


FIG. 38.

The visceral layer, however, comes into relation with the viscera, and the connections which it forms with these give rise to the complexity of the membrane.

In order to obtain a proper display of the pelvic fascia, it is necessary to dissect it from three different aspects, viz.—(1.) From above; (2.) From below; (3.) From the side. The arrows in the diagram indicate the directions in which the dissection must be made. It is preferable to choose the *right side.* The chief structures which have to be removed are also seen.

Dissection from Above.—This dissection is undertaken with the view of exposing the pelvic surface of the fascia. Strip the peritoneum from the *right side* of the pelvic wall by means of the fingers. It should also be partially removed from the same side of the bladder. On carefully scraping away the loose fatty extra-peritoneal tissue with the handle of the knife or with the finger nails, the pelvic fascia will be brought into view. To expose it anteriorly, the bladder must be forcibly dragged backwards from the pubes, and the intervening areolar tissue taken away. At this point the pelvic fascia will not be encountered until we have descended to within half-an-inch from the lower end of the symphysis. Here it is so thick that it is beyond injury so long as we work with the fingers, or the handle of the knife, but laterally it is thin, and great care must be taken. The extra-peritoneal tissue which surrounds the internal iliac vessels must also be removed, and the relation of their parietal branches to the fascia made out.

Dissection from Below.—The object of this dissection is to expose the perineal surface of the fascia. The pelvis must be placed so that the outlet looks upwards. The fat having previously been removed from the ischio-rectal fossa, divide the inferior hæmorrhoidal vessels and nerves if they are still present, and then raise the levator ani muscle from the side of the rectum. To do this the muscle must be cut transversely about an inch above the anus. At first the levator ani will be observed to rest upon the side of the gut, separated from it, however, by a well-marked layer of fascia (the rectal layer of pelvic fascia), but as the dissector proceeds with the dissection the muscle will be found higher up to be in close contact with the under surface of the visceral layer of the pelvic fascia. Lastly, he will come to the line of origin of the muscle from the pelvic fascia—*i.e.*, the line along which the visceral layer leaves the parietal layer—and here he must stop.

In the dissection of the ischio-rectal fossa (p. 9), the parietal pelvic fascia was exposed and recognised as forming the outer wall of the space. The entire inner surface of the parietal portion, both in its pelvic and perineal parts, is, therefore, now exposed, and, if the levator ani be drawn outwards and the pelvis held up to the light, the visceral pelvic fascia will be seen passing inwards from the parietal part to the viscera.

But it is also necessary to obtain a view of the outer aspect of the parietal pelvic fascia, and, for this purpose, the following dissection must be made.

Dissection from the Side.—To reach the pelvic fascia from this aspect a portion of the bony wall of the pelvis must be removed, and the obturator internus muscle raised from its position. The outer aspect of the innominate bone must first be thoroughly cleaned by removing the remains of the obturator externus muscle and all adhering portions of muscle from the pubic and ischial bones; carefully preserve, however, the obturator nerve and artery as they emerge from the upper part of the thyroid foramen. The membrane which closes the thyroid foramen may also be taken away. This will expose a part of the outer surface of the obturator internus muscle. Next, define the great and small sacro-sciatic foramina and the structures which emerge from and enter the pelvis through these apertures.

The section of the bone may now be made. This simply consists in taking away that portion of the innominate bone which bears the acetabulum. The first step is to snip through the spine of the ischium, close to its root, by means of the bone pliers. The saw must next be adopted, and the bone sawn through above and below the acetabulum—(1.) the first cut

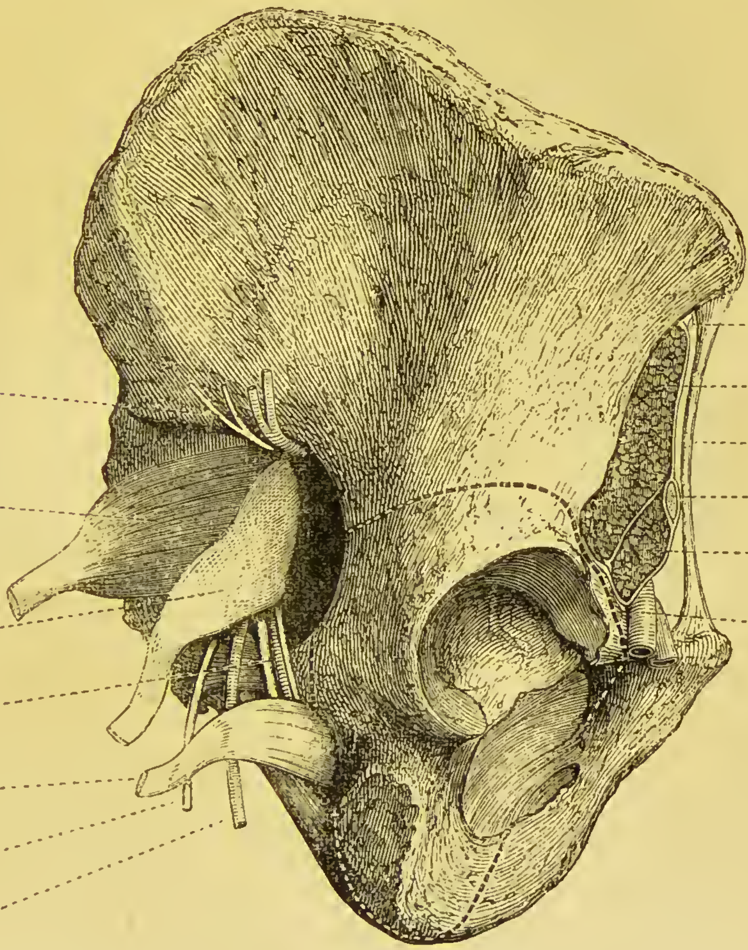


FIG. 39.

should extend from the upper part of the thyroid foramen to the upper part of the great sciatic notch; and (2.) the second through the ischial tuberosity from the lower end of the thyroid foramen to the lower end of the small sciatic notch. The direction in which the saw is to be carried in making these sections is indicated by dotted lines in Fig. 39. In the case of the first section, the direction will be somewhat influenced by the depth of the acetabulum. In no case, however, is it wise to enter the saw lower than the anterior inferior spine of the ilium, and this is the point at which the

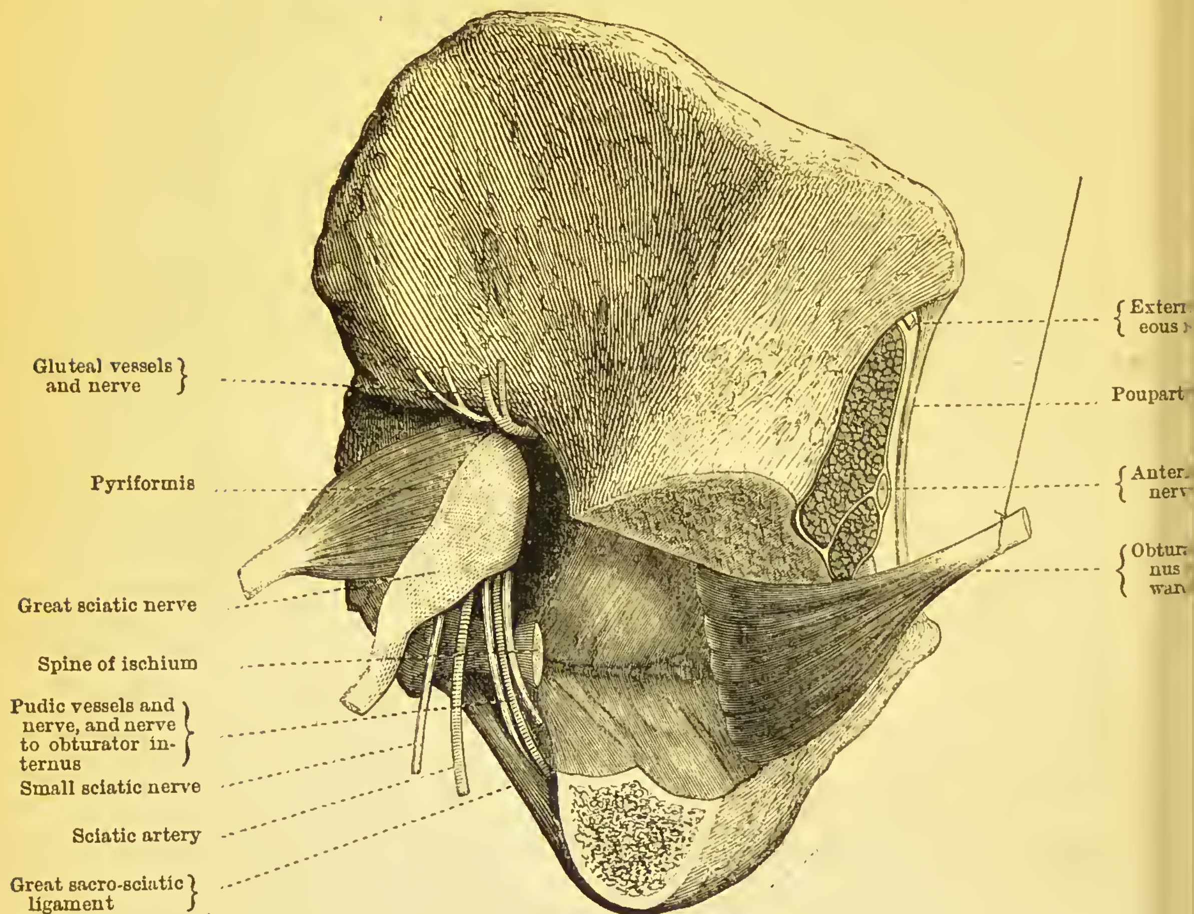


FIG. 40.
The white line of the pelvic fascia is seen in shadow.

cut should be commenced. In all probability it will be found necessary to complete this section in front by means of the bone pliers, as there are many cases in which it is impossible to bring the saw out at the two points indicated. The greatest care must be taken not to break the horizontal ramus of the pubic bone.

In carrying out the second or lower section, the dissector will meet with no difficulty whatever.

The section of bone being successfully performed, the detached portion should be raised from the subjacent obturator internus. The fibres of this muscle take origin from the deep surface of the bone, and it will thus be necessary to use the knife in effecting the separation. Lastly, clean the obturator internus, and, grasping its tendon, draw it gently outwards and upwards, as in Fig. 40. The outer aspect of the parietal pelvic fascia comes into view. By this dissection the student is afforded a striking illustration of the three morphological planes referred to on p. 226, as entering into the composition of the pelvic wall.

Description of the Pelvic Fascia.—The dissector has already taken note of a continuous fascia lining the interior of the abdomen proper, and placed between the muscles on the one hand, and the extra-peritoneal fatty tissue and peritoneum on the other. In relative position the pelvic fascia is identical with the abdominal fascia, and the visceral layer of the former which passes inwards upon the upper surface of the pelvic diaphragm, may be compared with the thin cellular layer which clothes the under surface of the abdomino-thoracic diaphragm ; the one completes the aponeurotic wall of the great abdominal cavity below, whilst the other completes it above. But, whilst this is the case, it must be borne in mind that the abdominal and pelvic fasciæ are only directly continuous with each other over a very limited part of the posterior portion of the ilio-pectineal line.

Parietal Pelvic Fascia.—The parietal or lining portion of the pelvic fascia must be examined from three different points of view, viz.—(1.) posteriorly; (2.) laterally; (3.) anteriorly. On the *posterior wall* of the pelvis, the parietal pelvic fascia, is of little importance. It is simply represented by a thin cellular membrane covering, the anterior aspect of the pyriformis muscle, and the sacral plexus of nerves.

Laterally, it is strong and dense, and its connections must be carefully studied. Superiorly, it is attached for a distance of about one inch to the back part of the ilio-pectineal line, where it will be observed to be directly continuous with the fascia iliaca, which is inserted into the same line; but the attachment of both to the bone is weak, so that by passing a probe down behind the latter the continuity of the two membranes can be determined. In front of this, the line of attachment of the parietal pelvic fascia leaves the ilio-pectineal line; it descends obliquely along the superior border of the obturator internus muscle to the upper margin of the thyroid foramen, and, opposite the groove on the under surface of the horizontal ramus of the pubic bone, there is a break in its bony attachment. At this point it turns over the upper margin of the obturator internus, and, joining the thyroid membrane on the other side, converts the groove into a canal. From this onwards the line of attachment upon the posterior aspect of the body of the pubis gradually sinks, and in front, it is found as low as the inferior border of the symphysis. There is thus a considerable part of the inner surface of the pelvis below the level of the ilio-pectineal line, and the crest of the pubis devoid of fascial lining. Here no continuity can be shown to exist between the iliac and pelvic fasciæ, except through the medium of the periosteum.

From the line of attachment thus indicated the parietal pelvic fascia descends upon the inner or deep surface of the obturator internus muscle, and is attached inferiorly to the tuberosity of the ischium and to the great and small sciatic ligaments. Traced forwards, it will be found to be fixed to the rami of the pubis and ischium in front of the obturator internus. In this manner, therefore, it may be said to have an attachment to the pelvic outlet from the symphysis to the sacrum. When followed backwards, the fascia will be noticed to pass over and close the great sacro-sciatic foramen, and then to turn inwards at an angle to reach the anterior aspect of the sacrum.

We have previously seen that the parietal pelvic fascia gives off from its inner surface a layer called the *visceral layer*, which proceeds inwards towards the viscera, and acts as a partition between the pelvis and the perineum. The line along which this takes origin extends around the pelvic wall, from the spine of the ischium behind to a point in front, a little above the level of the lower end of the symphysis. Along this line the fascia is denser and more opaque, and consequently it receives the name of the *white line*. It can always be seen by an examination of the outer surface of the pelvic fascia (Figs. 40 and 41). But the "white line" has a still wider significance. It also indicates the fascial origin of the levator ani muscle. Again, above this line, the parietal pelvic fascia is in relation to the pelvic cavity, and its inner surface is clothed by

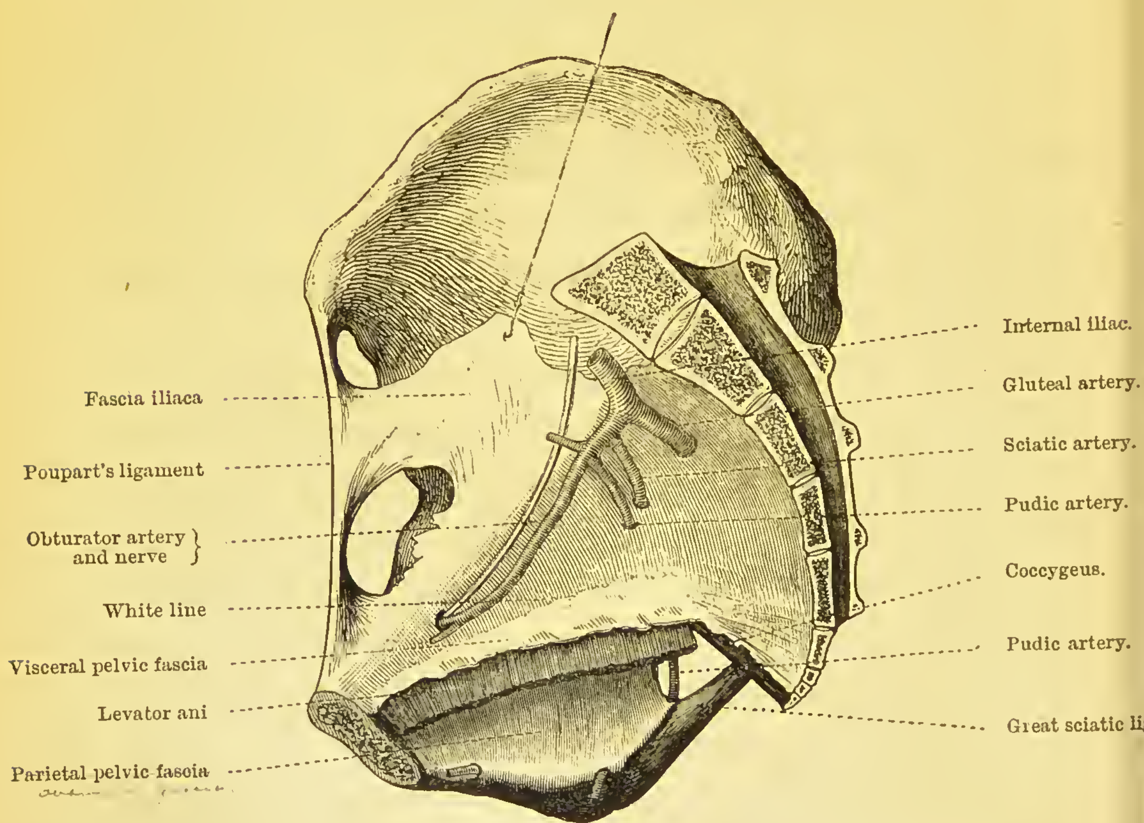


FIG. 41.

peritoneum; below the line, it belongs to the perineum, and forms the outer wall of the ischio-rectal fossa, where its inner surface is in relation to the fat which fills up this space. The perineal part of the parietal pelvic fascia is frequently called the *obturator fascia*, from its relation to the obturator internus muscle. About an inch and a-half above the tuberosity of the ischium, the internal pudic vessels and nerves pass forwards in a tube formed by this fascia (p. 29), and the inferior hæmorrhoidal and superficial perineal branches pierce it as they proceed to their destination.

The student has now examined the parietal pelvic fascia posteriorly and laterally. He must next look to its disposition *in front* of the pelvis—*i.e.*, opposite

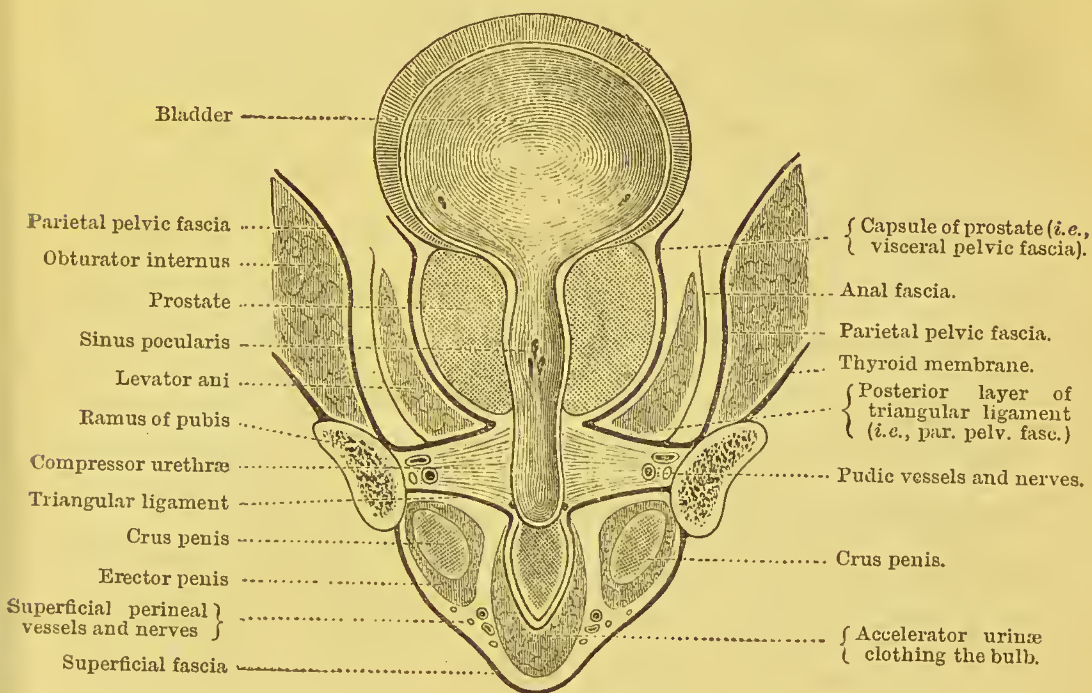


FIG. 42.

DIAGRAM. Vertical section through the pubic arch to show the two perineal compartments and their contents, and also the manner in which the parietal pelvic fascia blends with the visceral pelvic fascia.

the pubic arch. He must not suppose, because it has an attachment to the side of the pubic arch, that it stops there. It is continued onwards behind the compressor urethræ muscle, across the arch, and in this situation it is generally known as "*the posterior layer of the triangular ligament.*" Reaching the urethra, it sweeps backwards around the anterior border of the levator ani, and joins the visceral layer (Fig. 42). Inferiorly, it is attached to the base of the triangular ligament, which, as we have seen, is on the same morphological plane as the bone ; consequently this attachment is quite in keeping with the attachment of the fascia further back, to the tuberosity of the ischium, and to the sciatic ligaments.

Visceral Layer of Pelvic Fascia.—In the greater part of its extent the visceral pelvic fascia springs from the inner surface of the parietal pelvic fascia, along the *white line.* In front, however, it has a limited attachment to the back of the body of the pubic bone *above* the attachment of the parietal layer. It is from the portion of bone between these layers that the anterior fibres of the levator ani arise. The visceral pelvic fascia now passes inwards upon the upper surface of the levator ani muscle to the side of the prostate and the base of the bladder, and divides into *three layers*, termed—(1.) the vesical ; (2.) the recto-vesical ; and (3.) the rectal. These have different connections, according to the point at which they are examined.

In the region of the bladder, the splitting of the visceral pelvic fascia takes place at the outer margin of the vesicula seminalis, and the *vesical*, or *highest layer*, turns upwards upon the lower part of the side of the bladder, and constitutes its "*lateral true ligament.*" Upon the wall of this viscus the vesical prolongation gradually thins away until it is ultimately lost upon its coats. The *recto-vesical*, or *intermediate layer*, is carried inwards between the bladder and the rectum, and, in the mesial plane, it becomes continuous with the corresponding layer of the opposite side. As it proceeds inwards it splits to enclose and form a capsule for the vesicula seminalis and the vas deferens. The *rectal*, or *lowest layer*, is prolonged downwards upon the side of the rectum—between it and the levator ani muscle—and then, turning backwards behind the gut, it becomes continuous with the same layer of the other side. The rectum is thus enclosed in a sheath formed by the recto-vesical and rectal layers of the pelvic fascia.

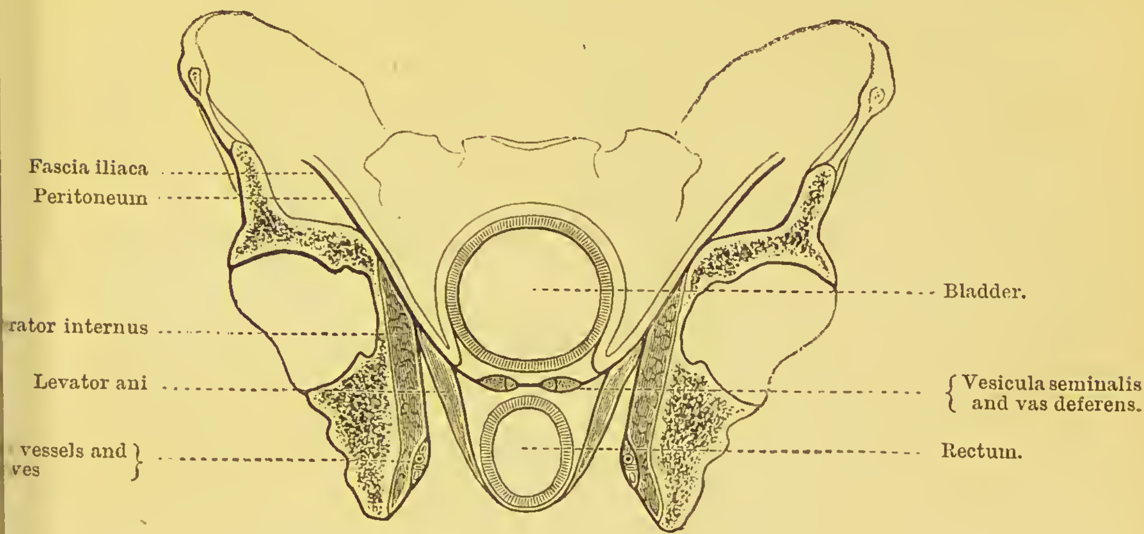


FIG. 43.

Proceeding forwards to the region of the prostate and the neck of the bladder, the connections of the three layers will be found to be somewhat altered. Substitute the prostate for the bladder, and carry the vesical layer upwards over it, so as to meet its fellow of the opposite side, and the arrangement will be understood (Fig. 44). The prostate is thus enclosed in a capsule, the walls of which are exceedingly strong and dense. But at this point the lower part of the rectum passes backwards to reach the surface, and as it does so it pushes itself through the rectal layer, carrying downwards upon its walls a thin tubular prolongation of the fascia (Fig. 45).

The arrangement of the visceral pelvic fascia in front of the pelvis must next be studied. The student has already noted that here the visceral layer has a direct attachment to the posterior aspect of the body of the pubic bone close to the lower end of the symphysis, and above the bony origin of the anterior fibres of the levator ani, and the attachment of the

FIG. 44.

parietal pelvic fascia. Draw the bladder backwards and look down between it and the pubic bones. The *vesical layer* will be seen to pass backwards on each side of the symphysis, in the form of a strong, rounded, and cord-like band, which proceeds over the prostate to the anterior aspect of the bladder. These cord-like bands are the *anterior true ligaments of the bladder*, or if they are looked at merely in their relations to the pubes and the prostate they are called the *pubo-prostatic ligaments.* In the middle line there is a very evident interval or recess between them, so deep in some cases that the tip of the little finger can be introduced into it. The dorsal vein of the penis passes backwards in this groove. The fascia is not deficient at the bottom of this furrow. It is prolonged from one side to the other over the dorsal vein, so as to hide it from view. But what is the disposition

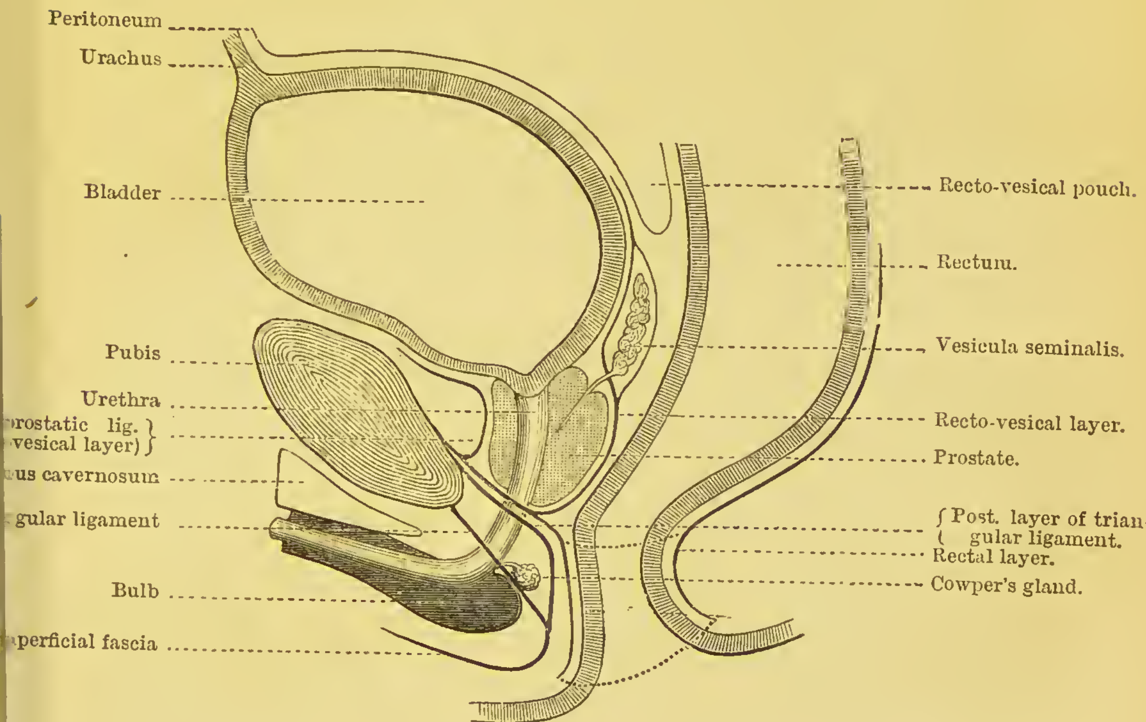


FIG. 45.

This diagram represents the pelvic fascia in section a short distance to the outer side of the mesial plane, beyond the point at which the parietal and visceral layers blend ; hence both are seen in section.

of the *recto-vesical* and *rectal layers* at this point? The parietal pelvic fascia (posterior layer of the triangular ligament), as we have seen, sweeps backwards round the anterior margin of the levator ani (Fig. 42, p. 241). It now blends with the recto-vesical layer, and closes the prostatic capsule in front, whilst at a lower level it is joined by the rectal layer.

Anal Fascia.—It is necessary, before leaving the pelvic fascia, to take notice of a layer which has already been studied in connection with the perineum—viz., the *anal fascia.* This is a thin and delicate aponeurosis which covers the perineal or lower surface of the levator ani, and which is connected with the pelvic fascia along the *white line.* In consequence of this attachment, it is usually described as a distinct layer of the pelvic fascia, whereas it is merely the aponeurosis of the muscle. The levator ani is thus enclosed between two aponeurotic lamellæ—viz., the visceral pelvic fascia and the rectal fascia above, and the anal fascia below.

Relation of Blood-Vessels and Nerves to Pelvic Fascia.—The blood-vessels of the pelvis are placed on the peritoneal aspect of the fascia. It follows, therefore, that the parietal branches of the internal iliac artery, in passing out of the pelvis, pierce the membrane, and they always carry with them a prolongation from it which blends with their sheaths (Fig. 41, p. 240). There is an exception to this rule—viz., the *obturator artery.* It has been observed to pass over the upper border of the parietal pelvic fascia. The nerves, on the other hand, lie *outside* or *behind* the fascia, and do not require to pierce it in emerging from the pelvis. This difference in the relation of the nerves and blood-vessels can be well studied by looking at the fascia as it passes over the great sacro-sciatic foramen.

Dissection.—The *right* innominate bone should now be removed, in order that a side view of the pelvic viscera may be obtained. The first step to take is to divide the visceral layer of the pelvic fascia from behind forwards, about half-an-inch from the white line. Next, saw through the pubic bone, half-an-inch external to the symphysis, and divide the great sacro-sciatic ligament close to the sacrum. The further separation of the bone should be effected at the sacro-iliac articulation by means of the saw.

In connection with the detached innominate bone, a good view may be obtained of the fascial origin of the levator ani (Fig. 41, p. 240), and also of the origin of the obturator internus. It is better, however, to defer the description of these muscles until the viscera are removed.

The dissector should in the next place turn his attention to that portion of the visceral layer of the pelvic fascia which has been left attached to the viscera. Follow it as far as possible in its reflections upon them, but preserve intact the capsule of the prostate. When thoroughly satisfied upon this point, remove what remains of the fascia on the right side, and clean the viscera, taking care not to injure the blood-vessels and nerves which supply them. This dissection will be much facilitated if the rectum be moderately stuffed with tow, and the bladder partially inflated with air. In the case of the rectum, first cleanse it thoroughly by allowing water from the tap to run freely through it, and in the case of the bladder, first pass a staff into it through the urethra, and having placed a ligature around the penis, introduce the air through a blow-pipe thrust into one of the ureters.

When the vesical layer of fascia is divided, a plexus of large veins will be discovered upon the bladder. These veins ramify over the entire organ, but are especially numerous towards the base and in the angle between the vesical and recto-vesical layers of pelvic fascia. These veins constitute what is termed the *vesical plexus.*

The vesiculæ seminales must be carefully defined, and the obliterated hypogastric artery and the vas deferens followed upon the side of the bladder.

Pelvic Viscera.

Rectum.—This is the terminal part of the great intestine. It begins at the left sacro-iliac articulation, where it is continuous with the sigmoid flexure, and ends on the surface a short distance in front of the coccyx, in an orifice termed the *anus.* Its length is about eight inches, and although its walls are no longer sacculated and pouched like those of the colon, it does not present a uniform diameter throughout. At first its calibre corresponds with that of the lower part of the colon, but as it descends, it gradually dilates. Immediately above its termination, it presents a wide expansion, and then contracts to form the anus. In its course through the pelvis, the rectum is adapted to the concave anterior surface of the sacrum and coccyx, and is commonly divided, from changes in its direction and connections, into *three* parts. This subdivision is purely arbitrary, and merely adopted for the purpose of rendering the description more exact.

The *first part* of the rectum, about three and a-half inches long, extends from the left sacro-iliac articulation obliquely downwards, backwards, and to the right, and ends in the mesial plane upon the body of the third sacral vertebra. In this part of its course, the rectum is completely clothed by peritoneum, and is connected to the anterior surface of the sacrum by a short peritoneal fold called the meso-rectum. Between the two layers of this fold, the superior hæmorrhoidal artery will be observed descending to supply the gut. The first part of the rectum is in relation *posteriorly* to the sacrum, the left pyriformis muscle, and the left sacral plexus of nerves, separated from them, however, by the peritoneum. In relation to its *left side* are the left ureter and branches of the left internal iliac vessels. *In front* it is separated from the posterior surface of the bladder by the recto-vesical peritoneal pouch, and, it may be, by some coils of small intestine contained within this pouch.

The *second part* of the rectum, about three inches in length, descends in the middle line to the tip of the coccyx. It is in contact with the anterior surface of the sacrum and coccyx, and consequently describes a curve, the concavity of which is directed forwards. The peritoneum at first clothes it anteriorly and laterally; soon, however, it leaves the sides of the gut, and finally (about an inch above the end of this part of the rectum) quits it altogether, and is reflected on to the bladder. Below the reflection of the peritoneum the rectum is in relation anteriorly to the base of the bladder. Only a small triangular portion of the bladder, however, is in direct apposition with the gut; externally to this, on each side, the vas deferens and the seminal vesicle intervene between them.

The *third part* of the rectum, about one and a-half inches long, bends downwards and backwards to reach the anus. It is totally destitute of peritoneum, but upon each side it is clothed and supported by the rectal layer of the pelvic fascia and the levator ani muscle, whilst its orifice is embraced by the sphincter ani. The prostate is in relation to it anteriorly at its commencement—in fact, at the very point where it takes the bend. The membranous portion of the urethra and the bulb of the penis are also anterior to it, but owing to the backward inclination of the gut they are not in contact with it, but are separated from it by an angular interval.

The staff, which has been introduced into the bladder, being held in the middle line, the student should pass the forefinger of the right hand into the rectum, and endeavour to distinguish by touch the parts in relation to the anterior aspect of the gut. Passing beyond the bulb, the staff, as it lies in the membranous part of the urethra, will be felt very distinctly; next, the prostate will be encountered; and, immediately behind this, the finger, provided it is carried upwards exactly in the middle line, will rest upon the small triangular surface of the base of the bladder, which is in contact with the rectum—the recto-vesical layer of pelvic fascia alone intervening.

The Bladder.—This is a hollow, musculo-membranous viscus which acts as a temporary reservoir for the urine, before it is emitted from the body by the process of micturition. As will be readily understood, its form, and in a great measure its position and relations, are much influenced by the quantity of fluid which it contains. *When empty*, it lies entirely within the pelvic cavity, and is flattened and collapsed; further, it is somewhat triangular in form, and rests upon the symphysis and the bodies of the pubic bones. *When distended*, it assumes an ovoid shape, and, rising above the pubis, enters the hypogastric region of the abdomen proper. In this condition it presents for examination an apex and base; an anterior, posterior, and two lateral surfaces; and a neck. The long axis of the distended bladder is directed from before backwards, and slightly downwards, from the apex to the base.*

The *apex* or *summit* of the bladder is directed forwards, and rests upon the posterior aspect of the anterior abdominal wall. From its centre a strong fibrous cord, the *urachus*, proceeds upwards in the middle line to the umbilicus.† The peritoneum gives a partial covering to the apex; it clothes it as far forwards as the urachus, which conducts it to the abdominal wall. The *base* of the bladder looks

* In Braune's plates, the long axis of the bladder is represented as being horizontal (*vide* PLATE I *b*).

† This is a very interesting structure from a developmental point of view. It shows the connection which exists between the bladder and the allantoidal sac of the embryo. At an early stage of development the sac of the allantois consists of an extra-abdominal and an intra-abdominal portion, which communicate with each other through the umbilicus. In course of time the extra-abdominal part disappears. The fate of the intra-abdominal part is different; its lower portion is developed into the bladder, whilst its upper portion shrivels and becomes the urachus.

backwards towards the concavity of the second part of the rectum. It is not in actual contact with the gut, however; above, it is separated from it by the lower part of the recto-vesical pouch of peritoneum, and below this by the recto-vesical layer of pelvic fascia, the vasa deferentia, and the vesiculæ seminales. The ureters open into the upper part of the base.

The *anterior surface*, which looks downwards and slightly forwards, is devoid of peritoneum, and is connected to the symphysis, the pubic bones, and the lower part of the anterior abdominal wall by some loose areolar tissue. The *posterior surface* is directed upwards and slightly backwards, and is covered by peritoneum. Intervening between it and the rectum is the recto-vesical pouch of peritoneum and any coils of intestine that this may chance to contain. Upon the *lateral surface* the obliterated hypogastric artery and the vas deferens will be found. As the latter descends towards the base, it will be noticed to cross to the inner side of the obliterated hypogastric artery. This aspect of the bladder is clothed by peritoneum as far forwards as the obliterated hypogastric artery; along the line of this fibrous cord it quits the viscus and passes to the iliac fossa and the lateral wall of the pelvis.

The *neck* or *cervix* of the bladder is that part from which the urethra issues. It is surrounded by the base of the prostate, and is directed downwards.

The Ureters.—After entering the pelvis, the ureter of each side proceeds towards the base of the bladder in the posterior false vesical ligament at a lower level than the obliterated hypogastric artery. It enters the bladder about two inches behind the prostate, and about the same distance from its fellow of the opposite side.

The Prostate.—This is a solid body, partly glandular and partly muscular, which embraces the neck of the bladder and surrounds the first part of the urethra.

In shape, it is conical, and somewhat resembles a Spanish chesnut—its base being directed upwards and backwards, and its apex downwards and forwards. *In size*, it is variable; but its average dimensions are commonly stated to be about one and a-quarter inches from base to apex, and one and a-half inches from side to side at its broadest part. The prostate rests upon the anterior aspect of the rectum at the junction of the second and third parts. It is therefore one and a-half inches distant from the anus, whilst its upper surface lies fully three-quarters of an inch below the symphysis pubis.

Capsule of the Prostate.—The prostate has already been noticed to be enclosed within a dense capsule derived from the pelvic fascia, and when the constitution of this capsule is analysed, it will be seen that the vesical, recto-vesical, and parietal layers of this fascia all enter into its composition. The vesical layer, in which the pubo-prostatic or anterior true ligaments of the bladder are developed, forms the anterior part; the recto-vesical layer closes it behind; whilst the same layer and the parietal pelvic fascia complete it below. These points are brought out in a diagrammatic manner in Figs. 42, p. 241; 44, p. 244;

and 45, p. 245. This capsule prevents the prostate altering its position in response to the continual changes in the state of distention of the bladder.

Prostate Plexus of Veins.—Open into the capsule and lay bare the prostate. It will be found to be surrounded, particularly towards the base, by a dense network of veins. The dorsal vein of the penis passes backwards in relation to the upper surface of the prostate, and, after dividing into two, joins this plexus.

Constitution of the Prostate.—Two median grooves, one upon its anterior or pubic surface, and the other upon its posterior or rectal surface, indicate the subdivision of the prostate into *two lateral lobes*. This is further marked by a median notch in the posterior aspect of the base. A *third* or *middle lobe* is also present. It is a small piece interposed between the lateral lobes on the one hand, and the posterior aspect of the neck of the bladder and first part of the urethra on the other.

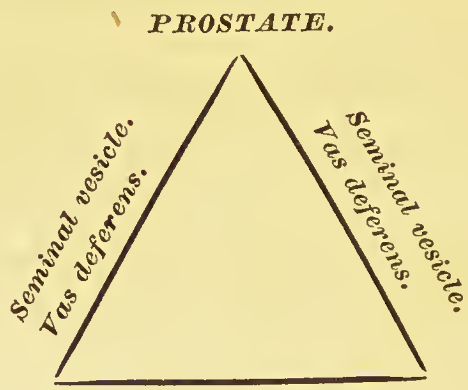
Relations of the Prostate.—*Anteriorly*, the prostate is in relation to the pubo-prostatic ligaments and the dorsal vein of the penis; *posteriorly*, it rests upon the rectum; *laterally*, it is supported by the anterior fibres of the levator ani, which, from this relation, receive the name of *levator prostatæ; inferiorly*, the urethra emerges from its apex; whilst *superiorly*, its base embraces the neck of the bladder, and the common ejaculatory ducts are received into the interval between its middle and lateral lobes.

Vesiculæ Seminales.—These are two sacculated receptacles for the semen, which intervene between the base of the bladder and the second part of the rectum. Conical or somewhat pyriform in shape, each seminal vesicle presents a narrow anterior end in close proximity to the base of the prostate, and an expanded or blunt posterior end in relation to the recto-vesical pouch of peritoneum. In front, they are near to each other and the mesial plane, but they diverge widely as they proceed backwards, so that posteriorly they are separated by a considerable interval. The vas deferens lies along the inner side of each. In length, the vesicle measures about two inches. By introducing a blow-pipe into the narrow anterior extremity and inflating it with air a demonstration of its capacity may be obtained.

Each vesicula seminalis is in reality a closed tube, five or six inches long, coiled upon itself and held in its present form by dense areolar tissue. When unravelled, several diverticula will be observed to proceed from the main tube. The narrow anterior end of the vesicle joins the vas deferens at an acute angle to form the *common ejaculatory duct.*

Vas Deferens.—The vas deferens, or duct of the testicle, has already been traced to the internal abdominal ring, through which it enters the abdomen. Separating itself from the other factors of the spermatic cord, it now hooks round the deep epigastric artery, and descends upon the inner side of the external iliac artery into the pelvis. Here it is continued downwards upon the lateral surface of the bladder, and crosses the obliterated hypogastric artery. Then passing to the inner side of the ureter, it reaches the base of the viscus, where it becomes dilated and slightly sacculated, and lies upon the inner side of the seminal vesicle. As it proceeds onwards, it gradually inclines towards the mesial plane, and at the base of the prostate it is joined by the narrow end of the vesicula seminalis of its own side.

Triangle on the Base of the Bladder.—A line drawn from the middle of one seminal vesicle to a corresponding point in the other would, under ordinary



circumstances, indicate the line along which the peritoneum is reflected from the anterior aspect of the rectum on to the back of the bladder; or, in other words, the depth of the recto-vesical cul-de-sac of peritoneum. This line, taken in conjunction with the converging vasa deferentia and vesiculæ seminales, maps off a triangular space upon the base of the bladder—the apex of which is at the base of the prostate, whilst the base is formed by the reflection of the peritoneum.

Within the limits of this triangle the base of the bladder is separated from the rectum by the recto-vesical layer of pelvic fascia alone.

It occasionally happens that in retention of urine, it is impossible to pass a catheter into the bladder to relieve the distention. In these cases it becomes necessary to puncture the bladder with a trocar and canula. The foregoing facts concerning the relations of this viscus will show that the operation may be performed at two points without injury to the peritoneum—viz., (1.) in the middle line immediately above the pubic symphysis; (2.) through the rectum and within the limits of the triangular space on the base of the bladder. In the distended condition of the bladder, the peritoneum is absent from its walls at both of these points. The latter method is the one which is preferable, except where the retention is due to enlargement of the prostate, in which case it would in all probability be impossible to reach the point at which the puncture should be made. The middle line must be adhered to rigorously in both methods.

Pelvic Blood-Vessels.

The blood-vessels of the pelvis should now be followed out. For this purpose it is necessary to remove the stuffing from the rectum, and allow the air to escape from the bladder. The peritoneum upon the left side and the loose tissue around the vessels must be dissected away. Accompanying the arteries the dissector should notice numbers of fine nervous twigs from the pelvic plexus, and from the third and fourth sacral nerves. Preserve these as far as it is possible to do so. Upon the right side the blood-vessels are more or less injured, and some of them severed, by the removal of the innominate bone; on the left side, however, they are intact.

The pelvic arteries are the following:—

(1.) The internal iliac and its branches (upon each side).
(2.) The middle sacral
(3.) The superior hæmorrhoidal } (in the mesial plane).

The Internal Iliac Artery.—This is a short, wide vessel which commences opposite the lumbo-sacral articulation, at the bifurcation of the common iliac. It proceeds downwards and backwards into the pelvis, and ends near the upper part of the great sciatic notch by dividing into an *anterior* and *posterior* division. In length it measures about one and a-half inches, and its calibre in the adult is considerably smaller than that of the external iliac. *In front*, it is clothed by the peritoneum, and crossed by the ureter; whilst *behind*, it rests upon the pyriformis muscle, the lumbo-sacral cord, and the internal iliac vein. The impervious hypogastric artery extends forwards from its extremity.

Condition in the Fœtus.—Very different is the condition of the internal iliac artery in the fœtus. It is termed the *hypogastric artery*, and is twice as large as the external iliac. Instead of terminating at the sciatic notch, it extends forwards to the side of the bladder, upon which it ascends to reach the abdominal parietes. Continuing its course upwards upon the posterior aspect of the anterior wall of the abdomen, it gains the umbilical orifice, through which it passes in company with its fellow of the opposite side and the umbilical vein. Outside the abdominal cavity the hypogastric arteries are important factors in the constitution of the umbilical cord, and, twining spirally around the umbilical vein, they reach the placenta, where the impure blood which they hold is brought into relation with the maternal blood.

After birth, when the umbilical cord is divided and a ligature placed around it, the hypogastric arteries become filled with clot, which is gradually absorbed. At the same time the vessels

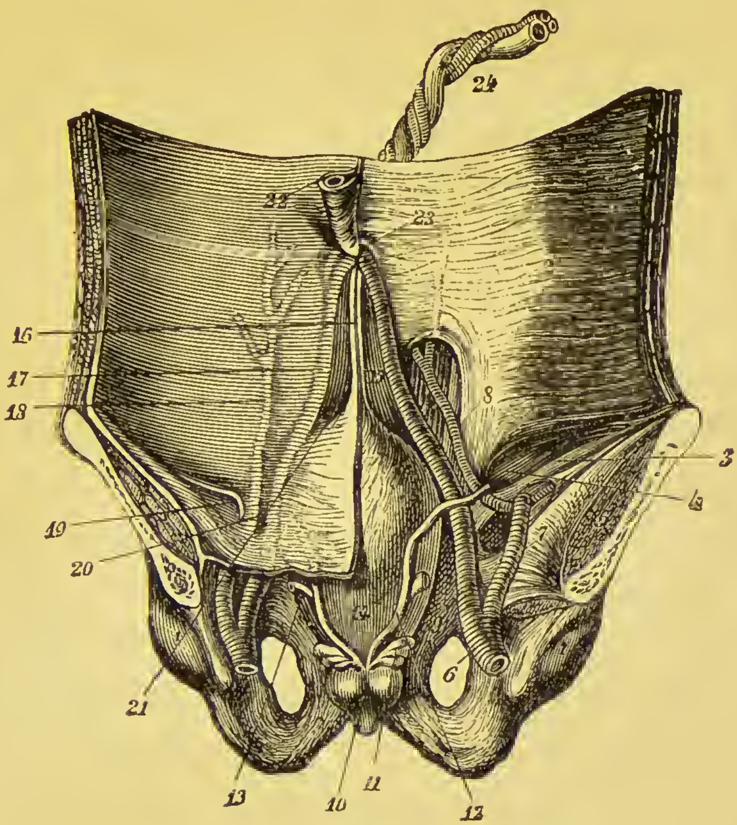


FIG. 46.

View of the posterior aspect of the anterior wall of the abdomen and pelvis in the fœtus to show the hypogastric artery. On the right side the peritoneum and fascia transversalis has been removed.—*From* LUSCHKA'S *Anatomy.*

(1) Os innominatum.
(2) Transversalis muscle.
(3) Poupart's ligament.
(4) Inguinal canal.
(5) Iliacus muscle.
(6) Common iliac artery.
(7) External iliac artery.
(8) Deep epigastric artery.
(9) Thyroid foramen.
(10) Prostate.
(11) Vesicula seminalis.
(12) Vas deferens.
(13) Ureter.
(14) Bladder.
(15) Urachus.
(16) Fold of the urachus.
(17) Hypogastric artery covered by peritoneum.
(18) Deep epigastric artery covered by peritoneum.
(19) External inguinal pouch.
(20) Middle inguinal pouch.
(21) Internal inguinal pouch.
(22) Umbilical vein.
(23) Umbilicus.
(24) Umbilical cord.

shrivel, and after a few years they are merely represented by the fibrous cords which we have examined in the adult. A small portion of this cord, close to the internal iliac artery, usually remains patent, and from this the superior vesical artery takes origin.

Branches of the Internal Iliac.—The branches of this artery spring from the two divisions into which it divides, and may be tabulated thus :—

Anterior Division.		Posterior Division.	
Parietal.	Visceral.	Parietal.	Visceral.
(1.) Obturator.	(1.) Superior vesical.	(1.) Ilio-lumbar.	......
(2.) Internal pudic.	(2.) Inferior vesical.	(2.) Gluteal.	......
(3.) Sciatic.	(3.) Middle hæmorrhoidal.	(3.) Lateral sacral.	......

Superior Vesical.—Under this name are included two or three small twigs which spring from the pervious part of the obliterated hypogastric artery, and proceed forwards in the posterior false ligament of the bladder to the coats of that viscus. They supply the summit and the greater part of the body of the bladder, and from one of them a minute twig, the *artery to the vas deferens*, is given to the seminal duct. Although exceedingly slender, this branch can be followed along the vas as far as the testicle.

Inferior Vesical.—This artery will be recognised from its distribution. It ramifies upon the base of the bladder, and sends twigs to the vesiculæ seminales. A branch called the *vesico-prostatic* also takes origin from the inferior vesical, and runs downwards upon the lateral lobe of the prostate to supply its substance.

The *middle hæmorrhoidal* almost invariably proceeds from the inferior vesical. It is given to the coats of the rectum, and anastomoses above with the superior hæmorrhoidal termination of the inferior mesenteric, and below with the inferior hæmorrhoidal twigs from the internal pudic.

The *obturator artery* proceeds forwards upon the inner aspect of the pelvic wall to the upper part of the thyroid foramen. Here it comes into relation with the nerve of the same name, and both leave the cavity by passing above the pelvic fascia and through the groove upon the under surface of the horizontal ramus of the pubic bone. Within the pelvis it lies in the extra-peritoneal fatty tissue, between the peritoneum and the parietal pelvic fascia; the obturator nerve is placed at a higher level, whilst the vein lies below it. In this part of its course the obturator artery furnishes a small *iliac branch* to the parts in the iliac fossa, and a minute *pubic branch*, which ramifies upon the back of the pubic bone and anastomoses with a similar branch from the deep epigastric artery.

The *pudic artery* is now seen in the *pelvic part* of its course. It proceeds downwards upon the pyriformis muscle and sacral nerves, and reaching the lower part of the great sacro-sciatic foramen, it leaves the pelvis by passing through it. In the gluteal region it appears between the pyriformis and the superior gemellus.

The *sciatic artery* can be recognised from its being the largest of the branches which spring from the anterior division of the internal iliac, and also from its generally lying a little behind the pudic. It proceeds downwards upon the pyriformis muscle and sacral nerves, and quits the pelvis for the gluteal region through the lower part of the great sacro-sciatic foramen.

The *ilio-lumbar artery* is directed upwards, outwards, and backwards behind the obturator nerve, the external iliac vessels, and the psoas muscle, to the iliac fossa, where it divides into a lumbar and an iliac branch. The *lumbar branch* runs upwards and ramifies in the substance of the psoas and quadratus lumborum muscles, where it anastomoses with the lower lumbar arteries. It gives off a small *spinal branch*, which enters the spinal canal through the intervertebral foramen between the last lumbar vertebra and the sacrum. The *iliac branch* breaks up into twigs, which run outwards, some in the substance of the iliacus muscle, and others between it and the bone; of the latter set, one will be observed to enter the nutrient foramen in the iliac fossa. Reaching the crest of the ilium, the terminal branches of this vessel anastomose with the deep circumflex iliac and lumbar arteries.

The *gluteal artery* is the largest of the branches of the internal iliac. It has a very short course within the pelvis. Passing downwards between the lumbo-sacral cord and the first sacral nerve, it leaves the pelvis through the upper part of the great sacro-sciatic foramen, and appears in the gluteal region in the interval between the pyriformis and gluteus minimus muscles.

The *lateral sacral* is usually represented by two arteries, which extend downwards upon the pyriformis muscle and sacral nerves, external to the anterior sacral foramina and the sympathetic cord. They furnish twigs to the parts upon which they lie, and branches which enter the sacral foramina. The latter, after supplying the membranes and nerve-roots within the sacral canal, emerge behind, through the posterior sacral foramina, and there anastomose with branches of the gluteal artery. The lower of the two lateral sacral arteries inosculates inferiorly with the middle sacral.

The Superior Hæmorrhoidal Artery.—This is the continuation into the pelvis of the inferior mesenteric artery. It descends behind the rectum, between the two layers of its mesentery, and soon divides into two branches which extend downwards, one upon each side of the gut. Near the end of the second part of the rectum these branches break up into numerous twigs, which surround the intestine. Approaching its external orifice, they pierce the muscular coat and continue downwards, subjacent to the mucous membrane, and at the anus they end by a series of anastomosing loops. The superior hæmorrhoidal anastomoses freely with both the middle and inferior hæmorrhoidal arteries.

Middle Sacral Artery.—The middle sacral has already been observed springing from the termination of the abdominal aorta, between the two common iliac arteries. It runs downwards upon the body of the last lumbar vertebra and under cover of the left common iliac vein. Reaching the sacrum, it continues its downward course in the mesial plane till it arrives at the coccyx. Here it ends by anastomosing with the lateral sacral arteries, and by sending minute branches to the coccygeal body. From each side it gives off small twigs, which ramify upon the anterior aspect of the sacrum, and inosculate with branches of the lateral sacral arteries.

Veins of the Pelvis.—The arrangement of the veins in the pelvis corresponds in a great measure with that of the arteries; still there are some important points of difference, viz.:—

(1.) The *dorsal vein of the penis*, instead of joining the pudic vein, proceeds backwards, divides into two, and enters the prostatic plexus of veins.

(2.) The *ilio-lumbar* and the *lateral sacral* veins, as a general rule, pour their blood into the common iliac veins.

(3.) The veins around the prostate, bladder, and lower end of the rectum are exceedingly large and numerous, and constitute dense plexuses, which freely communicate with each other. The *prostatic* and *vesical plexuses* have already been noticed. They are directly continuous, and the blood is drained from them by the vesical veins. The *hæmorrhoidal plexus* surrounds the lower third of the rectum subjacent to the mucous membrane. From this the blood is drained away by three different veins—viz., the inferior hæmorrhoidal, which carries it to the pudic vein; the middle hæmorrhoidal, which leads it to the internal iliac vein; and the superior hæmorrhoidal vein, which is one of the rootlets of the portal vein. The hæmorrhoidal plexus may therefore be regarded as being the link between the systemic and portal system of veins. This has an important bearing upon the production of hæmorrhoids, which consist in a varicose condition of the inferior hæmorrhoidal veins. As we have seen, the portal vein and its tributaries are devoid of valves; consequently, anything retarding the flow of blood through the portal system will react upon the hæmorrhoidal plexus, cause its distention, and predispose to hæmorrhoids.

The *internal pudic vein* proceeds upwards behind the artery of the same name, and joins the common iliac vein. With the exception of the ilio-lumbar and lateral sacral veins, it receives tributaries corresponding to the branches of the artery.

Pelvic Diaphragm.

The diaphragm of the pelvis should next be examined. It is composed of two muscles upon each side—viz., the *levator ani* and the *coccygeus*. Draw the viscera as far as possible to the right and remove what remains of the visceral layer of the pelvic fascia upon the left side. This will expose the upper surface of the levator ani, the connections of which can now be studied. In cleaning the coccygeus, be careful not to injure the fifth sacral nerve and the coccygeal nerve, both of which pierce it near its insertion.

Levator Ani.—The levator ani is a thin sheet of muscular fibres, and forms the anterior and greater part of the pelvic diaphragm. It has a triple origin. The *anterior fibres* spring from the back of the body of the pubic bone between the attachments of the visceral and parietal layers of pelvic fascia; the *posterior fibres* arise from the pelvic surface of the ischial spine; whilst the *intermediate fibres*, constituting the greater part of the muscle, take origin from the "white line" of the pelvic fascia, in the angle between the perineal portion of the parietal layer and the visceral layer.

The insertion of the levator ani must also be looked at from three points of view. The *anterior fibres* proceed downwards upon the lateral aspect of the prostate; and from the support which they give to it, they are frequently spoken of under the name of *levator prostatæ.* Behind the prostate they meet, in the mesial plane, with the corresponding fibres of the opposite side, and are inserted into the central point of the perineum. The *intermediate* and largest portion of the muscle descends upon the side of the rectum, into which it is inserted, some of the fibres mingling with those of the external sphincter. The *posterior fibres* are inserted into a median raphe behind the anus, and also into the side of the lower end of the coccyx.

The levator ani draws its nervous supply from the *fourth sacral nerve* and the *inferior hæmorrhoidal nerve.*

Coccygeus.—This is a small triangular muscle which lies behind and upon the same plane as the levator ani—indeed, their margins are contiguous. It arises by its narrow end from the pelvic surface of the ischial spine, and from the small sciatic ligament; expanding as it passes inwards, it is inserted into the margin of the lower piece of the sacrum and the margin and anterior aspect of the coccyx. It is supplied by twigs from the *fourth* and *fifth sacral nerves.*

Pelvic Nerves.

Spinal Nerves.—The anterior primary divisions of the spinal nerves in the pelvis are *six* in number—viz., *five sacral* and *one coccygeal.* These should next be dissected, and the various branches which they give off followed to their distribution, or the point where they quit the pelvis. In every case, it is well to begin by cleaning the lumbo-sacral cord and securing the *superior gluteal nerve* which springs from it. The *upper four sacral nerves* appear through the anterior sacral foramina; the *fifth sacral nerve* comes forward in the interval between the sacrum and coccyx; and the *coccygeal* a little lower down at the side of the coccyx. The two latter are very minute, but they can be easily found by following downwards a twig from the *fourth* to the *fifth* sacral nerve, and another twig which connects the *fifth* nerve with the *coccygeal.*

The first and second sacral nerves are very large and almost equal in size; the third sacral nerve is much smaller than these, and the fourth still smaller than the third. Each spinal nerve is joined by two twigs from the sympathetic cord.

The *first three sacral nerves* unite to form the *sacral plexus.* This is joined above by the *lumbo-sacral cord*, and below by a branch from the *fourth sacral nerve.*

The *fifth sacral nerve* and the *coccygeal nerve*, with the descending branch of the *fourth sacral nerve*, unite to form the *sacro-coccygeal plexus.*

Superior Gluteal Nerve.—This nerve springs from the lumbo-sacral cord before it enters the sacral plexus. It leaves the pelvis through the upper part of the great sacro-sciatic foramen above the level of the pyriformis muscle and in company with the gluteal artery. Entering the gluteal region, it supplies three muscles—viz., the gluteus medius, the gluteus minimus, and the tensor fasciæ femoris.

Sacral Plexus.—This differs in appearance from every other plexus in the body, as the nerves which enter it unite to form a single broad flattened band. This proceeds downwards and outwards to the lower part of the great sacro-sciatic foramen, and here, much reduced in width and increased in thickness, it enters

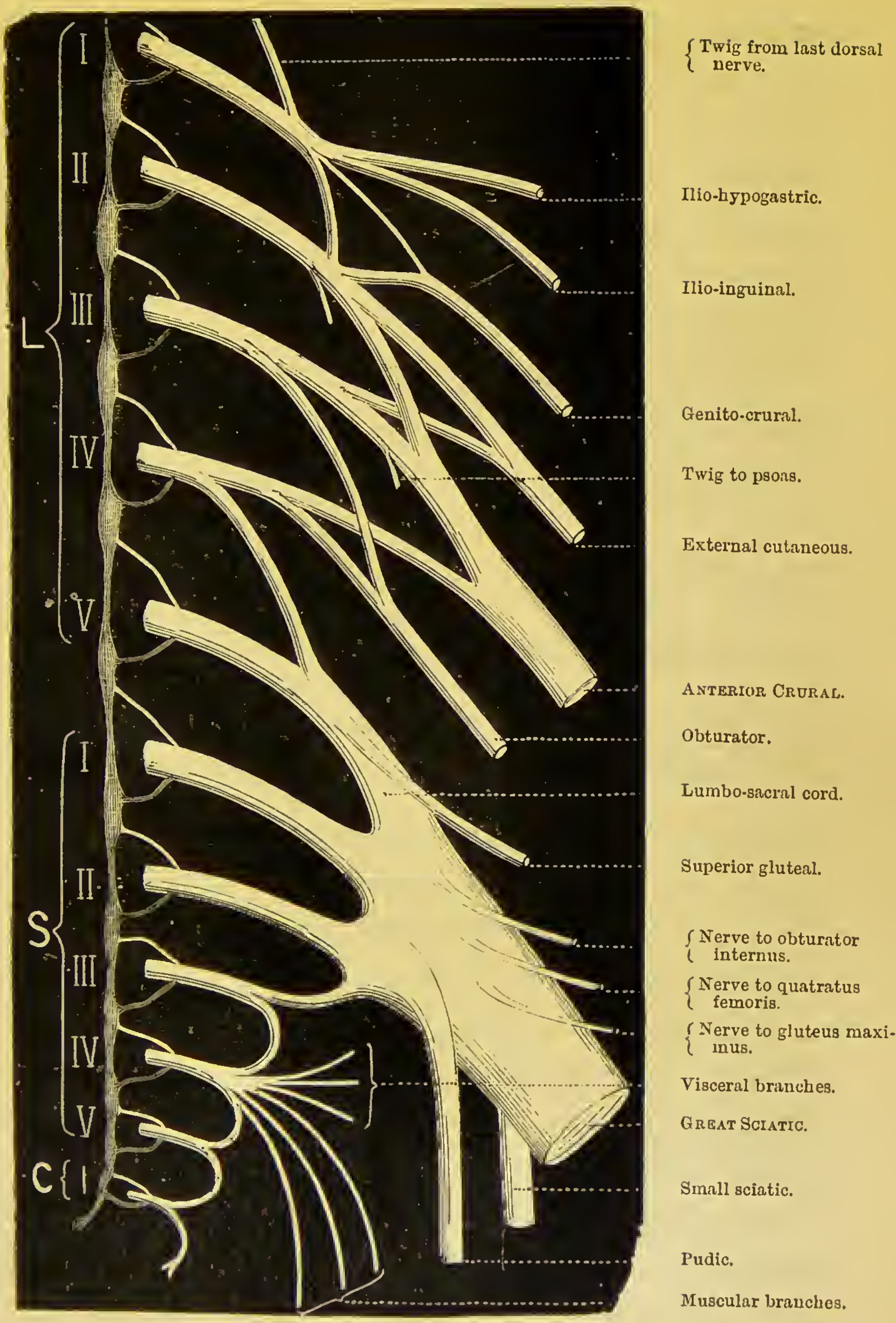


Fig. 47.
Diagram of the lumbar and sacral plexuses.

the gluteal region below the level of the pyriformis as the *great sciatic nerve.* This nerve, indeed, may be regarded as the direct continuation of the plexus into the thigh. The sacral plexus rests upon the pyriformis muscle; whilst, anteriorly, it is clothed by parietal pelvic fascia, which separates it from the branches of the internal iliac artery.

The following are the branches which proceed from the plexus :—

(1.) The great sciatic.

(2.) The internal pudic.

(3.) The small sciatic.

(4.) Nerves to the pyriformis.

(5.) Nerve to obturator internus and superior gemellus.

(6.) Nerve to quadratus femoris and inferior gemellus.

(7.) Special branches to the gluteus maximus.

The *great sciatic*, the *small sciatic*, and the *internal pudic* nerves all leave the pelvis through the lower part of the great sacro-sciatic foramen, and appear in the gluteal region in the interval between the pyriformis and the inferior gemellus.

The *special branches to the gluteus maximus* quit the pelvis at the same point, and enter the deep surface of that muscle.

The *nerves to the pyriformis* are usually two in number, and they may spring either from the plexus or from the sacral nerves before they enter the plexus.

The *nerve to the obturator internus* proceeds from that part of the plexus which results from the union of the lumbo-sacral cord with the first sacral nerve.

It accompanies the pudic nerve through the great sacro-sciatic foramen into the gluteal region, where it gives a twig to the superior gemellus. It reaches the obturator internus by passing through the small sacro-sciatic foramen, and ends by sinking into the inner aspect of this muscle.

The *nerve to the quadratus femoris* arises from the lower part of the plexus, and enters the gluteal region by passing through the lower part of the great sacro-sciatic foramen. It also supplies the gemellus inferior and a branch to the hip-joint.

Sacro-Coccygeal Plexus.—The *fourth sacral nerve*, as we have seen, sends upwards a branch to join the sacral plexus; it also sends a twig downwards to unite with the fifth sacral nerve. But in addition to these *connecting branches*, it gives off *muscular* and *visceral branches*.

The *muscular* branches are distributed to three muscles—viz., the levator ani, the coccygeus, and the sphincter ani externus. The last of these has already been dissected in the perineum, under the name of the "perineal branch of the fourth sacral nerve."

The *visceral* branches are very numerous, and are directed inwards towards the viscera. Here they join with the pelvic plexus of nerves. Some, however, may be found entering the viscera directly. Very frequently the third sacral nerve also gives off visceral branches.

The *fifth sacral nerve* pierces the coccygeus and appears in the pelvis. After being joined by the branch from the fourth sacral nerve, it turns downwards and unites with the coccygeal nerve. It supplies one or two minute filaments to the coccygeus muscle.

The *coccygeal nerve* is a very delicate filament. It emerges from the lower end of the sacral canal, and makes its appearance in the pelvis by piercing the sacro-sciatic ligament and the coccygeus muscle. It is now joined by the fifth sacral nerve and runs downwards. Near the tip of the coccyx it is directed backwards through the coccygeus muscle, and ends in the skin in this neighbourhood.

Pelvic Plexus of Sympathetic.—The dissector should in the next place make out the distribution of the sympathetic nerves within the pelvis. These have, no doubt, been considerably injured in previous dissections, but those which remain must be carefully traced. The hypogastric plexus has been observed to end inferiorly by dividing into two lateral portions, which are prolonged downwards, one upon each side of the rectum. These are termed the *pelvic plexuses*, and each consists of a dense mesh-work of sympathetic nerves. In addition to the branches from the hypogastric plexus, they receive numerous twigs from the sacral spinal nerves, more especially from the third and fourth, and the points at which these unite with the sympathetic filaments are marked by minute ganglia. The pelvic plexuses also acquire branches from the sacral portion of the sympathetic cord.

Prolongations from the pelvic plexus upon each side are sent along the various branches of the internal iliac artery. There are thus formed various secondary plexuses—viz., the *vesical plexus*, to the coats of the bladder, to the seminal vesicle and the vas deferens; the *hæmorrhoidal plexus* to the rectum; and the *prostatic plexus* to the prostate.

The prostatic plexus proceeds forwards between the prostate and the levator ani, and sends twigs to the erectile tissue of the penis. These latter are termed the *cavernous nerves.*

Gangliated Cord of Sympathetic.—The sympathetic cord as it enters the pelvis is considerably reduced in size. It proceeds downwards in front of the sacrum, along the inner side of the anterior sacral foramina. *Above*, it is continuous with the lumbar portion of the sympathetic cord, whilst *below*, it ends in the mesial plane in front of the coccyx in a minute ganglion, termed the *ganglion impar*, which acts as a bond of union between the cords of the two sides. The ganglia are very variable in number, but as a general rule there are five—one in relation to each sacral vertebra. Each of these is brought into connection with the spinal nerves by two short twigs.

The branches of these ganglia are chiefly distributed upon the anterior surface of the sacrum and around the middle sacral artery. A few filaments, however, are given to the hypogastric plexus, and some minute twigs proceed from the ganglion impar to the parts about the coccyx and to the coccygeal body.

Coccygeal Body.—This is a minute lobulated body about the size of a small pea, and situated in front of the tip of the coccyx. In structure it is partly vascular and partly nervous, and it is formed in connection with the terminal twigs of the middle sacral artery. It receives minute filaments from the ganglion impar.

Removal of the Viscera.—The viscera must now be removed from the pelvic cavity. Begin by dividing the vessels and nerves which enter them, the levator ani, and the anterior true ligaments of the bladder. Then sever the parts which hold the membranous portion of the urethra and the bulb of the penis to the pubic arch. Great care must be taken at this stage not to injure the delicate walls of the urethra, or to lose sight of Cowper's glands. Lastly, separate the rectum from its connections with the coccyx. Laying aside the viscera for a little, the dissector should study the muscles in relation to the pelvic wall—viz., the obturator internus and the pyriformis.

Obturator Internus.—This muscle clothes the lateral wall of the pelvis upon its inner aspect. Remove the parietal layer of the pelvic fascia, and it will come into view. It is a fan-shaped muscle, and has an extensive origin, viz.—(1.) from the entire circumference of the thyroid foramen, except above, where the obturator vessels and nerve quit the pelvis; (2.) from the deep surface of the membrane which extends across the foramen; and (3.) from the surface of bone behind the thyroid foramen as far back as the great sciatic notch. A few fibres are also derived from the parietal pelvic fascia which covers it. From this origin the fibres converge towards the small sciatic notch, and end in a tendon which issues from the pelvis through the lesser sacro-sciatic foramen. Entering the gluteal region, it is inserted into the upper part of the great trochanter of the femur. The small sciatic notch, over which the tendon glides, is coated with smooth cartilage, and this is raised into three or four parallel ridges, which fit into fissures upon the deep surface of the tendon. A synovial bursa intervenes between them.

The obturator internus is supplied by a special branch from the upper part of the sacral plexus.

The Pyriformis is placed against the anterior aspect of the posterior wall of the pelvis. It arises by three processes, from the anterior surface of the second, third, and fourth sacral vertebræ between the sacral foramina; it also takes origin from the innominate bone, where it forms the upper part of the great sciatic notch, and from the great sacro-sciatic ligament. The muscle leaves the pelvis through the great sacro-sciatic foramen, and is inserted by a rounded tendon into the top of the great trochanter of the femur. It is supplied by branches from the sacral plexus.

Coats of the Rectum.—Turning now to the viscera, separate the rectum from the bladder and prostate, and having stuffed it with tow, or inflated it with air, proceed to dissect its walls. It presents the same coats as the colon, viz. :—

(1.) Serous.
(2.) Subserous.
(3.) Muscular.
(4.) Submucous.
(5.) Mucous.

The *serous coat* has already been examined. It is complete in the first part of the rectum, partial in the second part, and altogether absent from the third part. The *subserous coat* is the loose flocculent areolar tissue which intervenes between the peritoneum and the muscular coat. In its lower part the rectum derives a sheath from the rectal layer of pelvic fascia.

The *muscular coat* is composed of two strata of involuntary nonstriated muscular fibres—viz., an *external* longitudinal and an *internal* circular layer. The *longitudinal fibres* are continuous above with the three longitudinal bands of the colon, but here they are spread out uniformly so as to form a continuous covering for the gut; they will be observed to terminate near the anus. The *circular fibres* extend transversely around the gut, and near the anus they are collected into a distinct circular band which surrounds the orifice, and is termed the *sphincter ani internus*.

The *submucous coat* differs in no respect from the same coat in the colon.

To see the mucous membrane it is necessary to slit open the rectum along its anterior wall.

The *mucous membrane* is somewhat thicker than that of the colon, and is more freely moveable upon the muscular tunic. In consequence of this mobility, it is thrown into irregular folds or rugæ when the gut is empty. Owing to the contraction of the sphincter ani, and the narrowing of the anal orifice, the folds at this point are longitudinal, and are termed the *columns of Morgagni*, or the *columnæ recti*. When the rectum is distended, all these rugæ disappear. In addition to the effaceable rugæ, there are three permanent oblique folds which must be noticed; one is situated at the level of the prostate—*i.e.*, at the junction of the second and third parts of the rectum—another about the level of the promontory of the sacrum, and the third is intermediate. With these folds the name of Houston is usually associated.

Coats of the Bladder.—The bladder must be fully distended with air before the dissection of its walls is commenced. It presents the same coats as the intestine, viz. :—

(1.) Serous.
(2.) Subserous.
(3.) Muscular.
(4.) Submucous.
(5.) Mucous.

The *serous covering* is partial and confined to its posterior aspect. The *subserous coat* consists of a thin stratum of areolar tissue, which binds the peritoneum to the muscular coat. The vesical layer of pelvic fascia may be considered to thin away into this coat.

The *muscular tunic* presents three layers of non-striated muscular fibres, viz. :—

(1.) External longitudinal fibres.
(2.) Circular fibres.
(3.) Internal longitudinal fibres.

The *external longitudinal fibres*, frequently termed the *detrusor urinæ*, give a continuous covering to the bladder, but are most apparent upon its anterior and posterior surfaces. In front they may be considered to spring from the back of the pubic bones and the base of the prostate. From this they mount upwards and spread out upon the anterior surface of the bladder. At the apex a few pass on to the urachus, but the majority are carried downwards over the posterior aspect and base of the bladder to the prostate, to which they are attached.

The *circular fibres* give a very thin and sparse covering to the bladder. In direction they are more oblique than transverse. At the neck of the bladder they become greatly increased in numbers, and, arranged in a distinctly circular manner, they form a thick bundle, which is termed the *sphincter vesicæ*.

The *internal longitudinal fibres* constitute a very feeble layer. Over the lower part of the bladder the stratum is tolerably complete; but, as it is followed upwards, the fibres open out and become oblique.

The *submucous coat* is the loose areolar bed in which the blood-vessels and nerves ramify before they enter the mucous membrane. It connects the mucous and muscular coats, and has a considerable amount of elastic tissue entering into its composition.

The *mucous membrane* which lines the bladder should now be examined, and, for this purpose, it is necessary to open up the viscus by an incision along its anterior aspect from the apex to the neck. It is better to lay open the first portion of the urethra at the same time by carrying the incision along the mesial plane through the anterior part of the prostate. When the mucous membrane is washed, it will be observed to be highly rugose, except over a triangular area immediately behind the urethral orifice. This rugosity is due to the loose manner in which the membrane is bound by the submucous layer to the muscular coat. When the bladder is distended, the folds are effaced and the mucous lining becomes smooth and even.

Orifices of the Bladder.—The *orifice of the urethra*, or the canal which conducts the urine from the bladder, is situated at the neck. Immediately behind this, the mucous membrane will be noticed to be elevated so as to form a slight prominence, which bulges forwards into the aperture. This elevation is termed the *luette*, or the *uvula vesicæ*, and it results from an accumulation or thickening of the submucous tissue at the spot. Probes should now be passed along the ureters into the interior of the bladder. By this means the dissector will be able to see how very obliquely these ducts pierce the walls of the bladder. Indeed, they traverse the wall for more than three-quarters of an inch before they reach the internal orifices. This arrangement, whilst it permits the passage of urine from the ureter into the bladder, acts as a valve in distention of the viscus, and prevents any backward flow of the urine into the ureters. The *openings of the ureters* are two slit-like apertures, which are placed about an inch and a-half apart from each other, and about the same distance from the luette or urethral orifice.

Trigone of the Bladder.—The three orifices of the bladder constitute the angles of an equilateral triangle, which is termed the *trigone*, the boundaries of which are formed by lines drawn between the openings of the ureters and from each of these forwards to the luette. The mucous membrane over this area presents a marked contrast to the same membrane in other parts of the bladder. Here it is always smooth, in whatever condition the viscus may be, and this is due to its being tightly bound down to the subjacent muscular coat. Again, it is more highly vascular, and has a more abundant supply of nerves. It is from the pressure of the urine against this highly sensitive portion of mucous membrane that the feeling which points to a necessity for micturition proceeds.

It is important to note that the trigone in the interior of the bladder corresponds with the triangular area on the exterior of the base, which is bounded by the vasa deferentia, the vesiculæ seminales, and the reflection of the recto-vesical peritoneal cul-de-sac.

Urethra.—The urethra is the canal through which the urine, the semen, and the secretions of the vesiculæ seminales, the prostate, and Cowper's glands are emitted from the body. It commences at the neck of the bladder and ends on the glans penis, and its average length is somewhere about eight or nine inches. It is customary to divide the urethra into three parts from the different character of the structures which it traverses. The *first* or *prostatic* portion is contained within the substance of the prostate gland ; the *second* or *membranous* portion extends from the apex of the prostate to the bulb of the corpus spongiosum penis, and is surrounded by the fibres of the compressor urethræ muscle; whilst the *third* or *spongy* part traverses the entire length of the corpus spongiosum.

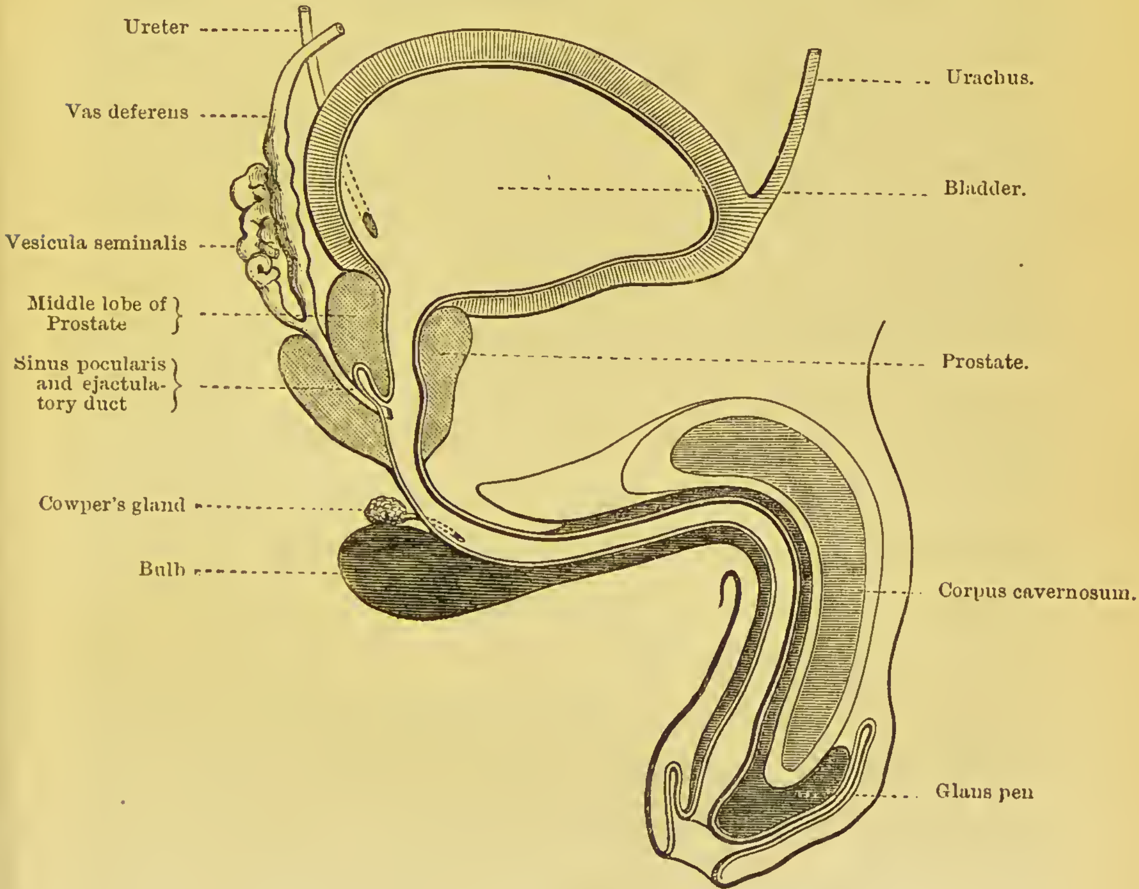


FIG. 48.

The urethral canal must now be laid open throughout its whole length, in order that its various parts may be studied. Lay the bladder and penis upon a block, and extend the incision which has already been made through the prostate, along the upper wall of the membranous portion of the urethra, and along the dorsum of the penis between the two corpora cavernosa and through the glans. This cut must be made as far as possible in the mesial plane.

Prostatic Portion of the Urethra.—This part of the urethra is about one and a quarter inches in length. It traverses the prostate in front of its middle lobe, and is therefore nearer the anterior than the posterior surface of this structure. It is the *widest* and at the same time the *most dilatable* part of the canal, and further, it is *fusiform*, being wider in the middle than at either its commencement or termination.

In connection with the floor of the prostatic portion of the urethra, there are certain very important features to be noted. The mucous membrane along the mesial plane is raised into a prominent ridge called the *verumontanum*.* This commences a short distance in front of the uvula vesicæ, and extends forwards for about three quarters of an inch. Posteriorly, it rises to a considerable height, but anteriorly, it gradually fades away. On each side of the verumontanum, the floor of the urethra is hollowed out into a longitudinal depression, termed the *prostatic sinus*, into which numerous prostatic ducts open. This may be rendered evident by squeezing the prostate, when fluid will be observed to exude into the sinus.

* Other terms are applied to this mesial ridge on the floor of the urethra—viz., *crest of the urethra*, *colliculus seminales*, and *caput gallinaginis*.

Immediately in front of the highest part of the verumontanum, the mucous membrane dips backwards and upwards behind the middle lobe of the prostate, and between the lateral lobes, so as to form a small recess or cul-de-sac. This is the *sinus pocularis* or the *utriculus*. Gauge its extent by means of a probe. It will be observed to be from a quarter to half-an-inch long, and to be very narrow at its orifice, but to widen out considerably towards its blind extremity. It is of interest, both from a developmental and a surgical point of view. It is the representative in the male, of the uterus and vagina in the female. Practically, it is important, because in some cases it is large enough to entangle the point of a small catheter or bougie.

The dissector should now pass bristles along the *common ejaculatory ducts*. They will be observed to run downwards between the middle and lateral lobes of the prostate. Finally, entering the wall of the sinus pocularis, they open by slit-like apertures, just within the margin of its orifice.

Owing to the presence of the verumontanum on the floor of the canal, and the prostatic sinus upon each side of it, a transverse section of the prostatic portion of the urethra presents a crescentic figure—the convexity of the crescent being directed forwards and the concavity backwards.

As old age approaches, the prostate is very liable to become enlarged, and the most important result of this is the effect which it exerts upon the urethra. When the enlargement is uniform, the prostatic portion of the canal is simply elongated;

when, however, the enlargement is confined to one lobe or part of a lobe, it impinges upon the urethra, and produces an alteration in its direction, and a consequent difficulty in micturition. When the middle lobe alone is increased in size, it projects forwards into the bladder so as to close the commencement of the canal.

The Membranous Portion of the Urethra.—This is the *narrowest* and the *shortest* division of the urethra. It extends from the apex of the prostate to the bulb of the penis, and describes a gentle curve from above, downwards and forwards, behind the lower border of the symphysis pubis, from which it is distant about one inch. Its length is fully three quarters of an inch, and its concavity is directed forwards and upwards, and its convexity backwards and downwards. Throughout its entire extent it is enveloped by the fibres of the compressor urethræ muscle, whilst towards its termination Cowper's glands are placed behind it—one on each side.

The relation of the membranous part of the urethra to the triangular ligament and the parietal pelvic fascia is very important. As it emerges from the prostate, the parietal pelvic fascia (*i.e.*, the posterior layer of the triangular ligament) sweeps backwards upon it to take part in the formation of the prostatic capsule. At its termination it pierces the triangular ligament about an inch below the symphysis pubis. It may therefore be looked upon as lying in the interval between these membranes.

The Spongy Portion of the Urethra.—This is the *longest* division of the urethra. It is embedded throughout in the substance of the corpus spongiosum penis, and shows considerable differences in its calibre as it is followed forwards to the glans. At each expansion of the corpus spongiosum there is a corresponding dilatation of the urethra. Thus the canal presents two dilatations—(1.) in the bulb, and (2.) in the glans; between these it is of uniform diameter, and slightly wider than the membranous part. The dilatation of the urethra in the glans is termed the *fossa navicularis.* At its orifice, which is termed the *meatus urinarius*, the canal is much contracted, and is even narrower than any part of the membranous portion. This aperture is a vertical slit, the lower end of which is connected with the prepuce by a fold of mucous membrane, termed the *frænum preputii.*

In the bulb and in the glans penis the erectile tissue of the corpus spongiosum is disposed very unequally around the urethra. In the former it is chiefly massed below or behind the tube, whilst in the glans it is chiefly placed in front and upon each side, a very thin layer covering it posteriorly.

The *ducts of Cowper's glands* open into the spongy portion of the urethra by piercing its floor about an inch in front of the triangular ligament. These orifices are extremely minute, and very difficult to find. By making a small hole in the wall of the duct as it emerges from the gland, and passing a fine bristle along it, the dissector may be able to detect the opening in the urethral floor. He will notice that the ducts proceed in the first place through the erectile tissue of the bulb, but towards their termination, they lie immediately subjacent to the mucous membrane.

The walls of the urethra are always in apposition except when urine is flowing through it. A transverse section through the spongy portion, except at its anterior part, would give the appearance of a transverse slit. In the fossa navicularis, however, the slit becomes vertical.

Mucous Membrane of the Urethra.—The mucous lining of the urethra is continuous posteriorly with that of the bladder, and anteriorly with the integument covering the glans penis. It is likewise continuous with the mucous membrane which lines the various ducts which open into the urethra. It is everywhere studded with the mouths of minute recesses, called *lacunæ.* These are particularly plentiful on the floor of the spongy part, and, as a general rule, they are directed forwards towards the meatus urinarius. One recess, specially deserving the attention of the student on account of its large size, is called the *lacuna magna;* and is usually placed on the roof of the fossa navicularis. Its orifice in rare cases is large enough to admit the point of a small bougie or catheter.

Direction of the Urethral Canal.—The prostatic portion is directed downwards and slightly forwards; the membranous part describes a slight curve behind the symphysis, the concavity of which looks forwards; whilst the spongy part at first ascends, and then curves downwards. The urethra, therefore, in the flaccid condition of the penis, takes a course in which there are two curves, like the letter ꙅ reversed. In the erect condition of the penis the curve in the spongy part of the canal is obliterated, and there is now only one curve, the concavity of which is directed upwards.

Vesiculæ Seminales.—If the dissector has not already unravelled the vesiculæ seminales, he should now do so, and, at the same time, endeavour to make out the composition of their walls. In addition to the recto-vesical fascia which ensheathes them, each vesicula has a strong dense fibrous tunic and a certain proportion of transverse and longitudinal non-striated muscular fibres. Open them up and expose the *mucous lining*. This is remarkable for its honey-comb or reticular appearance. In this respect, therefore, it is not unlike the mucous membrane of the gall-bladder, only the meshes are finer and the pits smaller.

Pelvic Articulations.

The nerves and blood-vessels of the pelvis must now be removed, and all adhering portions of muscle detached from the left innominate bone and the front and back of the sacrum. When this is done, the pelvis should be soaked for some time in warm water. By this proceeding the dissection of the ligaments will be rendered much easier.

The pelvis is fixed to the last lumbar vertebra, and its various parts are held together by the following articulations :—

(1.) Lumbo-sacral.
(2.) Sacro-coccygeal.
(3.) Coccygeal.
(4.) Sacro-iliac.
(5.) Pubic.

Lumbo-sacral Articulation.—The junction between the last lumbar vertebra and the sacrum is affected by an *amphiarthrodial joint*, which connects the body of the vertebra to the base of the sacrum, and by two *diarthrodial joints*, between the two pairs of articular processes. The ligaments which take part in holding the bones in position are :—

(1.) The capsular.
(2.) The anterior and posterior common vertebral.
(3.) The ligamenta subflava.
(4.) The inter and supra-spinous.
(5.) The sacro-vertebral, or lumbo-sacral.
(6.) The ilio-lumbar.

The *capsular ligaments* surround the articulations formed by the apposition of the articular processes, and each is lined by a synovial membrane.

The *anterior common ligament* of the vertebral column is continued downwards over the anterior aspect of the body of the last lumbar vertebra to the anterior aspect of the first segment of the sacrum. In a similar manner the *posterior common ligament* is prolonged downwards within the spinal canal, over the posterior aspect of the body of the last lumbar vertebra, to the upper part of that portion of the sacrum which forms the anterior wall of the sacral canal.

The *ligamenta subflava* are two short bands of yellow elastic tissue placed one on each side of the mesial plane. Superiorly they are attached to the anterior aspect of the lower border of the laminæ of the last lumbar vertebra; whilst inferiorly they are fixed to the posterior aspect of the laminæ of the first sacral segment, close to their upper margin.

The *interspinous ligament* connects the lower border of the spinous process of the last lumbar vertebra with the upper border of the spinous process of the first sacral vertebra. The *supraspinous ligament* is a thickened band which joins the tips of the same spinous processes.

So far, then, the ligaments of the lumbo-sacral articulation are identical with those which, above the level of the sacrum, help to bind the several segments of the spinal column together. The *sacro-vertebral* and *ilio-lumbar* ligaments have also their representatives higher up.

The *sacro-vertebral ligament* corresponds with the intertransverse ligaments. It is a strong triangular fibrous band attached by its apex to the tip and lower border of the transverse process of the last lumbar vertebra. Expanding as it proceeds downwards, it is fixed below to the posterior part of the base of the sacrum, where some of its fibres intermingle with those of the sacro-iliac ligaments.

The *ilio-lumbar ligament* may be considered to be the representative of the posterior costo-transverse ligament of the dorsal region. It is triangular in shape, and is fixed by its apex to the tip of the transverse process of the last lumbar vertebra. Proceeding horizontally outwards, it is inserted into the inner lip of the iliac crest at the posterior part of the iliac fossa.

The dissector has already noticed that the anterior lamella of the lumbar fascia is attached to the upper border of this ligament, and further, that it affords a surface of origin by its posterior aspect for the quadratus lumborum, and by its anterior surface for the iliacus muscle.

The *amphiarthrodial joint*, between the body of the last lumbar vertebra and the base of the sacrum, corresponds in every respect with the similar articulations above, between the bodies of the vertebræ. The opposed bony surfaces are each coated by a thin layer of cartilage, and are firmly united by an intervening disc of fibro-cartilage, which is dense and laminated externally, soft and pulpy towards the centre, where, indeed, a synovial cavity may in some instances be found. The dissector should observe, however, that this disc is the thickest of the series, and further, that it is thicker in front than behind.

Sacro-coccygeal Articulation.—This is an amphiarthrodial joint. The articulating surfaces are each covered by a thin cartilaginous plate, and these are united by a disc of fibro-cartilage. The joint is strengthened in front by an *anterior ligament*, which extends downwards from the front of the sacrum to the anterior aspect of the coccyx, and by a *posterior ligament* which, attached above to the border of the lower aperture of the sacral canal, proceeds downwards upon the posterior aspect of the coccyx. The latter ligament is much the stronger of the two. In addition, fibrous bands will also be found passing between the cornua of the sacrum and the coccyx.

As regards the *coccygeal joints* (when such exist), the union of the different segments of the bone is effected in the same manner as in the case of the sacrum and coccyx.

The student should now saw through the sacrum and coccyx in the mesial plane. By this proceeding he will obtain a view of the structure of the intervertebral discs, and at the same time be enabled to make out to better advantage the attachments of the posterior common vertebral ligament and of the ligamenta subflava.

Sacro-iliac Articulation.—The sacrum is wedged in between the two innominate bones, and is held fast in this position by the form of the articular surfaces and the ligaments which pass between the bones. These ligaments are—

(1.) The anterior sacro-iliac.
(2.) The posterior sacro-iliac.
(3.) The oblique sacro-iliac.
(4.) Great sacro-sciatic.
(5.) Small sacro-sciatic.

The *anterior sacro-iliac ligament* is by no means strong. It is composed of a series of short fibres stretching across in front of the joint, and connecting the bones anteriorly.

The *posterior sacro-iliac ligament* is exceedingly strongly marked. It consists of fibrous bands, which connect the rough surface on the posterior part of the lateral aspect of the sacrum with a corresponding rough surface on the ilium behind the auricular surface.

The *oblique ligament* is simply a part of the posterior sacro-iliac ligament specially thickened and having a special direction and attachments. Above, it is fixed to the posterior superior spine of the ilium; whilst inferiorly, it is inserted into the lateral tubercle of the third piece of the sacrum.

The *great sacro-sciatic ligament* has a wide attachment to the posterior inferior iliac spine and to the side of the sacrum and coccyx. Narrowing considerably as it proceeds downwards and forwards, it again expands and is inserted into the inner border of the tuberosity of the ischium. From this it sends upwards a sharp falciform edge, which extends forwards for a short distance upon the ascending ramus of the ischium, and gives attachment to the parietal pelvic fascia.

The *small sacro-sciatic ligament* is triangular in form. By its base it is fixed to the side of the sacrum and coccyx in front of the great sacro-sciatic ligament, the fibres of both mingling together;

by its apex it is attached to the spine of the ischium.*

The ligaments of the sacro-iliac joint should now be divided, and the two bones forcibly wrenched asunder. By this proceeding each articular surface will be seen to be covered with a plate of cartilage, between which a small space lined by synovial membrane may be observed, which partially separates them.†

Symphysis Pubis.—This is an example of an amphiarthrodial joint. In addition to the intervening disc of fibro-cartilage which connects the cartilage-covered

* The two sacro-sciatic ligaments convert the sciatic notches of the innominate bone into foramina. The following are the structures which pass through these :—

Great sacro-sciatic foramen.

(1.) Gluteal vessels and superior gluteal nerve.
(2.) Pyriformis muscle.
(3.) Sciatic and pudic vessels.
(4.) Great and small sciatic nerves.
(5.) Pudic nerve and nerve to obturator internus.
(6.) Special nerves to gluteus maximus and nerve to the quadratus femoris.

Small sacro-sciatic foramen.

(1.) Tendon of obturator internus.
(2.) Pudic vessels and nerve.
(3.) Nerve to obturator internus.

† The sacro-iliac joint is not immoveable, as is sometimes stated. Mr. Zaglas (*Monthly Journ. of Med. Sci.*, Sept., 1851) has proved that a slight amount of movement can take place—the sacrum moving round an imaginary line drawn transversely through its second piece from one side to the other. In the erect posture the promontory of the sacrum is withdrawn to the full extent from the symphysis; in bending the body forwards, it approaches, in a small degree, the symphysis, and, in consequence, the sacro-sciatic ligaments are rendered tense.

opposing surfaces of the two pubic bones, *four* ligaments are present, viz. :—

(1.) Anterior pubic.	(3.) Supra-pubic.
(2.) Posterior pubic.	(4.) Infra or sub-pubic.

The *anterior pubic ligament* is strongly marked, and consists of two layers of fibres—a superficial and a deep. The *superficial fibres* are oblique, and cross each other like the limbs of the letter X, mingling with the decussating fibres of the internal pillars of the external abdominal ring. The *deep fibres* are transverse, and extend across from one bone to the other.

The *posterior pubic ligament* consists of a very few fibres on the posterior aspect of the joint.

The *supra-pubic ligament*, like the preceding, is weak. It is placed upon the upper aspect of the symphysis, and stretches between the crests of the two pubic bones.

The *infra* or *sub-pubic ligament*, which is situated on the lower aspect of the joint, rounds off the apex of the pubic arch. It is a strong band, somewhat triangular in shape, which is attached on each side to the descending ramus of the pubic bone, and above, to the fibro-cartilaginous disc. Inferiorly it gives attachment to the triangular ligament of the urethra.

The saw should now be used, and a portion sliced off from the front of the joint. The intervening plate of fibro-cartilage can in this way be studied. It will be seen to be thicker and denser in front than behind. As a general rule, a small synovial cavity will be found towards its back part, and nearer its upper than its lower end.

The Obturator or Thyroid Membrane.—This is the membrane which stretches across the thyroid foramen. It is attached to the circumference of the foramen, except at its upper part, where it bridges across the groove on the under surface of the horizontal ramus of the pubic bone, and converts it into a foramen for the escape of the obturator vessels and nerves. At this point it is continuous over the upper border of the obturator internus muscle with the parietal pelvic fascia.

FEMALE PELVIS.

The contents of the female pelvis are the following:—

Viscera.
- (1.) The rectum.
- (2.) The bladder and urethra.
- (3.) The uterus and vagina.
- (4.) The uterine appendages.
  - Fallopian tubes.
  - Ovaries, &c.
  - Round ligament.

Blood-vessels.
- (1.) Internal iliac vessels and their branches.
- (2.) The superior hæmorrhoidal vessels.
- (3.) The middle sacral vessels.
- (4.) The ovarian vessels.
- (5.) Certain venous plexuses in connection with the viscera.

Nerves.
- (1.) The sacral and sacro-coccygeal plexuses and their branches.
- (2.) The obturator nerves.
- (3.) The pelvic part of the sympathetic.

The peritoneum is continued into the pelvis, and clothes some of the viscera completely and others partially.

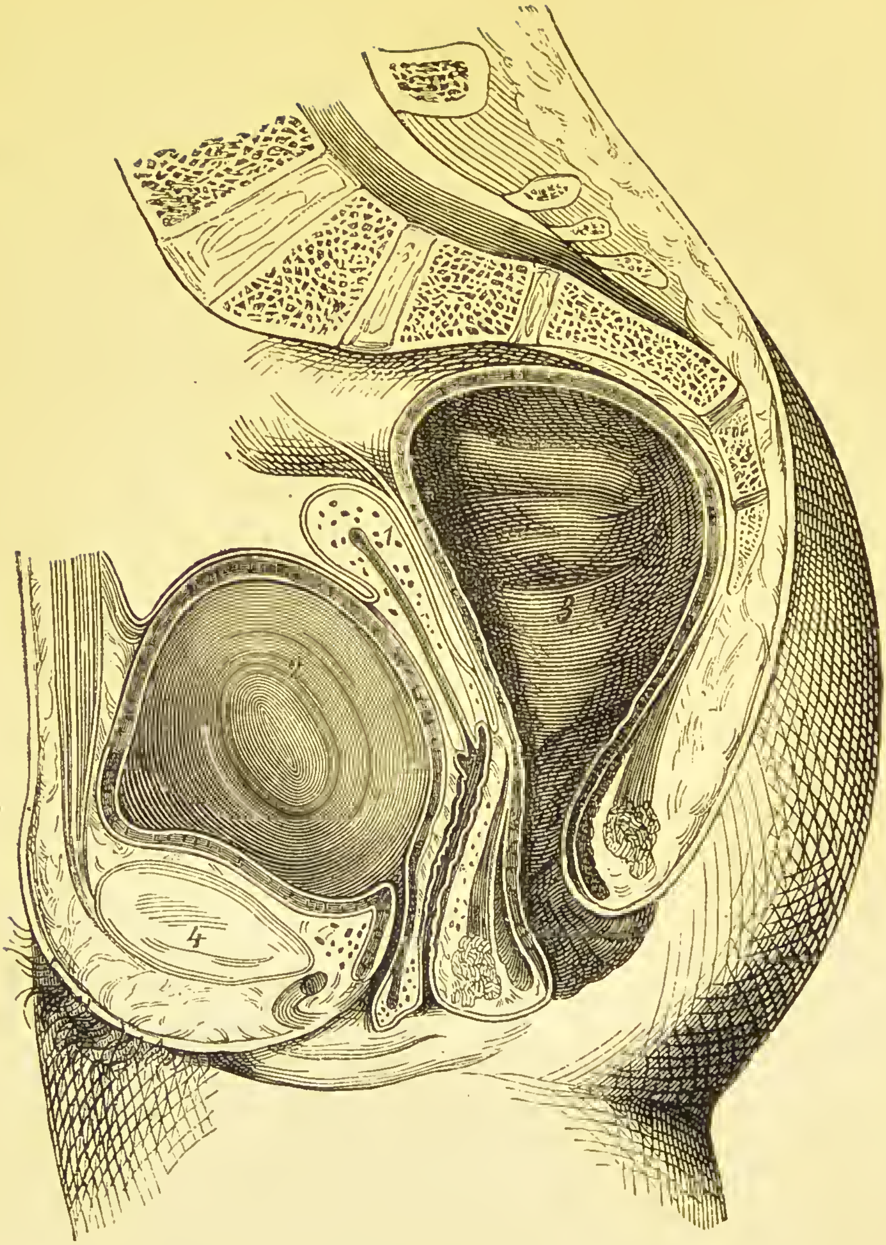


Fig. 49.

Mesial section through the pelvis of a virgin, after Legendre. The uterus is smaller than usual.—*From* Braune's *Atlas of Topographical Anatomy.*

(1) Uterus.	(3) Rectum.
(2) Bladder.	(4) Symphysis.

General Position of the Viscera.—The *rectum*, as in the male, occupies the posterior part of the pelvic cavity, and is adapted to the concavity of the sacrum and coccyx. The *bladder* and *urethra* are situated in front, the former lying against the posterior

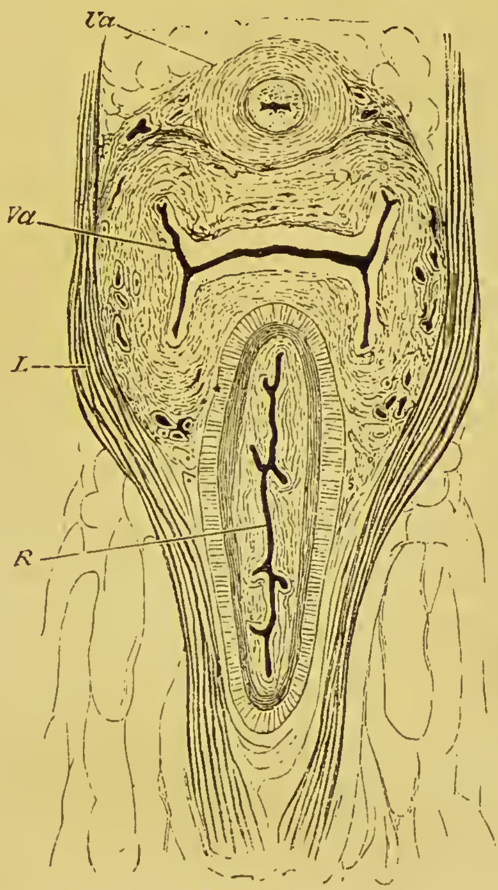


FIG. 50.

Horizontal section through the urethra, vagina, and rectum, a short distance above their terminations.—*From* CRUVEILHIER'S *Anatomie Descriptive.*

(*Ua*) Urethra.
(*Va*) Vagina.
(*L*) Levator ani.
(*R*) Rectum.

aspect of the pubic bones. The *uterus* and *vagina* are intermediate in position; whilst the *uterine appendages* are placed laterally. Three tubes or canals are thus directed downwards to open on the surface within the limits of the perineum—viz., (*a.*) the urethra; (*b.*) the vagina; (*c.*) the rectum.

Peritoneum.—The peritoneum, as it proceeds downwards from the posterior abdominal wall into the pelvis, comes into relation with the rectum, and gives it a partial covering. The first part of the gut it clothes completely and connects by means of a distinct fold, called the *meso-rectum*, to the anterior surface of the sacrum. Gradually it quits the rectum, leaving first its posterior surface, then its lateral, and finally its anterior surface. The peritoneum is now reflected on to the posterior wall of the upper part of the vagina, upon which it ascends to the posterior surface of the uterus, which it covers completely. Reaching the fundus of the uterus, it turns over this and descends upon the anterior aspect of the organ. This surface of the uterus it only invests in its upper three-fourths, and is then reflected on to the posterior aspect of the bladder. Whilst the vagina, therefore, receives a partial investment from the peritoneum posteriorly, it is altogether destitute of it anteriorly; and, again, whilst the entire posterior surface of the uterus is covered, the lower fourth of its anterior surface is bare, in so far as this membrane is concerned. From each lateral border of the uterus the peritoneum stretches outwards in the form of a wide fold called the *broad ligament*. This connects the organ to the wall of the pelvis and the iliac fossa.

Upon the bladder the peritoneum is carried upwards, and at its apex is conducted to the posterior aspect of the anterior abdominal wall by the urachus. On each side of the viscus it extends outwards as far as the obliterated hypogastric artery, along the line of which it quits the bladder, and is continued round the pelvic wall. A very important point to notice is, that the peritoneal membrane is much more adherent to the wall of the uterus than it is to the wall of the bladder.

Broad Ligament of the Uterus.—This is a wide fold of peritoneum which stretches from each lateral border of the uterus to the opposite part of the pelvic wall and iliac fossa. The *superior border* of the ligament is occupied by the *Fallopian tube*, the fimbriated free outer extremity of which opens into the peritoneal cavity. Here, therefore, a continuity is established between the mucous lining of the tube and the peritoneal membrane. At a lower level than the Fallopian tube two secondary folds will be observed in connection with the broad ligament. Of these one projects backwards and contains between its layers the *ovary and its ligament*, whilst the other is directed forwards and contains the *round ligament of the uterus*. From before backwards, then, the student will recognise between the layers of the broad ligament—

(1.) The round ligament of the uterus.
(2.) The Fallopian tube.
(3.) The ovary and its ligament.

In addition to these more conspicuous objects, the two layers of the broad ligament include between them other structures, viz.—(1.) the *parovarium;* (2.) the *uterine* and *ovarian* vessels, nerves, and lymphatics.

Recto-Vaginal Pouch, or the Pouch of Douglas.—This corresponds with the recto-vesical pouch in the male. *In front*, it is bounded by the peritoneum clothing the vagina and uterus; *behind*, by the membrane investing the rectum; whilst *on each side* it is limited by a semilunar fold, which proceeds forwards from the side of the rectum to the side of the uterus. Considerable importance is attached by the gynecologists to the fact that this pouch is slightly deeper on the left than upon the right side.

The Utero-vesical Pouch is much shallower than the preceding. It is placed between the uterus and the bladder, and it is limited laterally by two slight folds, termed the utero-vesical folds, which pass between these viscera.

False Ligaments of the Bladder and Uterus.—The false ligaments of the bladder are *five* in number, viz.—one superior, two lateral, and two posterior.

The *two posterior false ligaments* of the bladder are the utero-vesical folds, which extend between the uterus and bladder, and limit the utero-vesical pouch laterally.

The *superior false ligament* is that portion of the peritoneum which passes from the apex of the bladder on to the posterior wall of the abdomen. It is led away from the viscus by the urachus and the two impervious hypogastric arteries.

The *lateral false ligament* is the term applied to the peritoneum as it passes from each side of the bladder to the wall of the pelvis and the iliac fossa. This reflection has been seen to take place along the line of the obliterated hypogastric artery.

The false ligaments of the uterus are *four* in number—*two anterior* and *two posterior.* These are simply other names applied to the recto-uterine and utero-vesical folds.

It is a matter of some importance to the accoucheur to determine the changes which occur in the arrangement of the

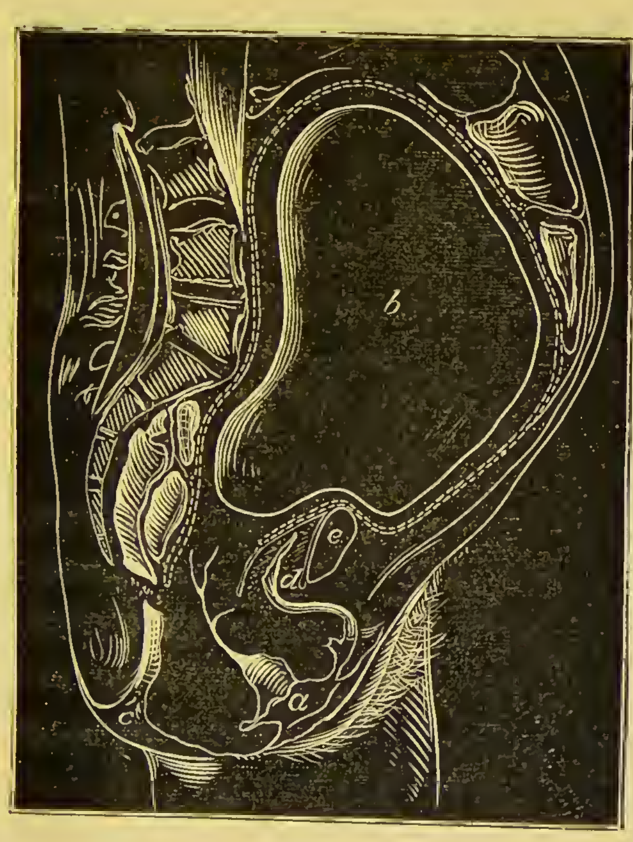


FIG. 51.

Vertical mesial section through the abdominal and pelvic cavities of a female towards the end of pregnancy, after Braune. —*From* HART'S *article on* "The Elongation of the Cervix during Labour," *Edin. Med. Journ.*, Sept., 1879.

(*a*) Vagina. (*b*) Uterus. (*c*) Rectum. (*d*) Bladder. (*e*) Symphysis.

The dotted line represents the peritoneum.

peritoneum within the pelvis during the progress of utero-gestation and parturition. As the uterus expands to make room for the growing fœtus contained within it, the investing peritoneum keeps pace with its growth, by an equivalent increase in its constituent elements (Fig. 51). William Hunter was of opinion that the enlarging uterus gradually insinuated itself between the layers of the broad ligament, and thus appropriated them for itself. This view, which at first sight seems so reasonable, has been abandoned, because it has been shown that this ligament does not disappear, but possesses an equal width in both the pregnant and non-pregnant uterus. A new and interesting fact has been lately brought forward by Dr. D.

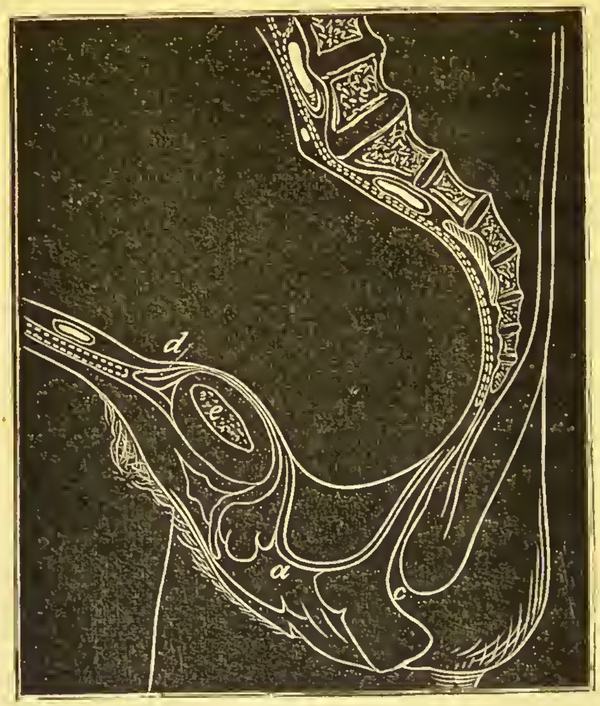


FIG. 52.

Mesial section through abdominal and pelvic cavities of a female in labour, after Braune.—*From* HART'S *article upon* "The Female Bladder," *Edin. Med. Journ.*, April, 1880.

(*a*) Vagina distended by the membranes.
(*c*) Rectum.
(*d*) Bladder above the pubis.
(*e*) Symphysis.

The dotted line represents the peritoneum drawn off the bladder.

Berry Hart of this University, with regard to the arrangement of the peritoneum during parturition. He points out that during labour the peritoneum is drawn upwards by the elongation of the cervix uteri, and stripped from the back of the bladder to such an extent that it remains merely in relation to the apex of this viscus (Fig. 52). This is rendered all the more extraordinary when we consider that the bladder is also dragged upwards so as to lie at a higher level than usual. Attention has already been called to the fact that the peritoneum is much more loosely attached to the bladder than to the uterus.

The relation of the peritoneum to the distended bladder is well seen in Fig. 53, and it will be seen that a distinction must be drawn between elevation of the bladder by its being dragged upwards by the elongation of the cervix uteri, and elevation of the bladder by the accumulation of fluid within it.

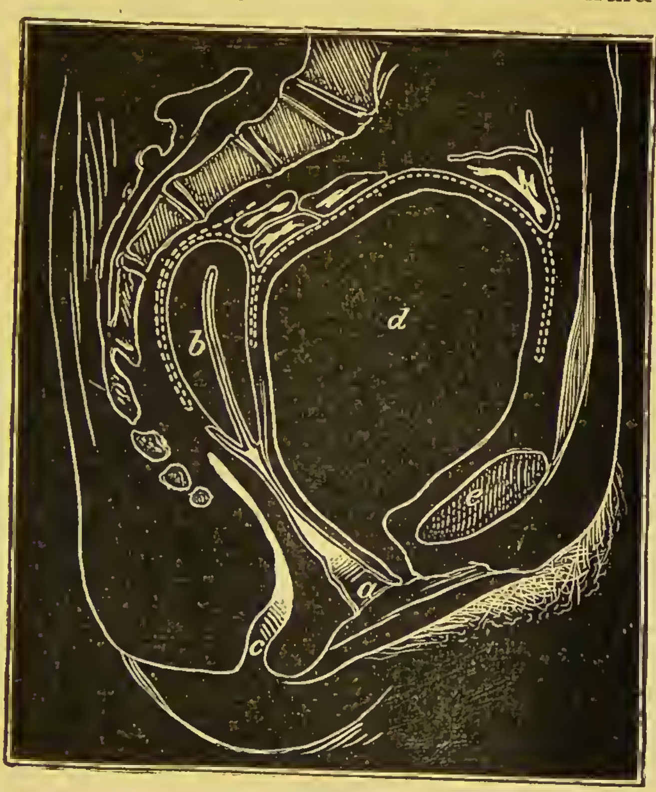


FIG. 53.

Vertical section through the female pelvis; bladder distended, after Pirogoff.—*Fom* HART'S *article on* "The Female Bladder."

(*a*) Vagina. | (*c*) Rectum.
(*b*) Uterus. | (*d*) Bladder.
(*e*) Symphysis.

The dotted line represents the peritoneum.

Hypogastric Nervous Plexus.—In no respect does it differ from that of the male (*vide* p. 231).

Pelvic Fascia.—For a description of the pelvic fascia and the manner in which it should be dissected the student is referred to page 231. The *parietal portion* is identical with that of the male, except in so far that in front it sweeps backwards upon the urethra and vagina, instead of the prostate, to join the visceral part. The *visceral portion* differs inasmuch as it gives a sheath to the vagina. Reaching the lateral aspect of the viscera, it thus divides into four layers, viz.—(1.) A *vesical layer*, which forms the lateral true ligament of the bladder; (2.) A *vesico-vaginal layer*, which passes between the bladder and vagina; (3.) A *recto-vaginal layer*, which proceeds inwards between the vagina and rectum; and (4.) A *rectal layer* for the lateral and posterior aspects of the rectum.

Dissection.—The right innominate bone should now be removed, in accordance with the directions given at p. 246, and the visceral layer of the pelvic fascia followed out in its various reflections upon the viscera. When thoroughly satisfied upon this point, remove the remains of the fascia and clean the viscera, taking care not to injure the blood-vessels and nerves which supply them. This dissection will be rendered easier, if the rectum and vagina be cleansed and moderately stuffed with tow. It is better also to partially inflate the bladder, but it is a difficult matter to retain the air when introduced; still it can be accomplished by sewing a fine thread round the urethral orifice, and tightening it like a purse-string as the blow-pipe is withdrawn.

Pelvic Viscera.

Rectum.—A detailed account of the rectum, as it is found in the male, is given at p. 248. It is only necessary, therefore, to mention here the points of difference in the female.

The relations and extent of the *first part* are similar in every respect, with one exception—viz., that the peritoneal cul-de-sac in front separates it, not from the bladder, but from the uterus.

The *second part* is also separated, for a short distance, by the recto-vaginal cul-de-sac from the uterus and vagina. Below this, however, it is in apposition with the posterior wall of the vagina—a layer of pelvic fascia (the recto-vaginal) alone intervening. The connection between the rectal and vaginal walls is at first very loose, but afterwards much more intimate. This has an important bearing upon the manner in which prolapsus uteri takes place.

The *third part*, at the tip of the coccyx, bends downwards and backwards, so that an angular interval is left between the gut and the vagina—an interval to which the term perineum is restricted by the accoucheur.

The Bladder.—The female bladder when distended, is rounder and not so ovoid in shape as in the male. The base, which is directed backwards and slightly downwards, is in relation to the neck of the uterus and the vagina. For further particulars regarding this viscus, the student may refer to p. 250, where the male bladder is described. He must bear in mind, however, that in the female there is no prostate surrounding its neck, no vas deferens upon its side, and no vesiculæ seminales in relation to its base.

According to Hart, the female bladder, when empty,

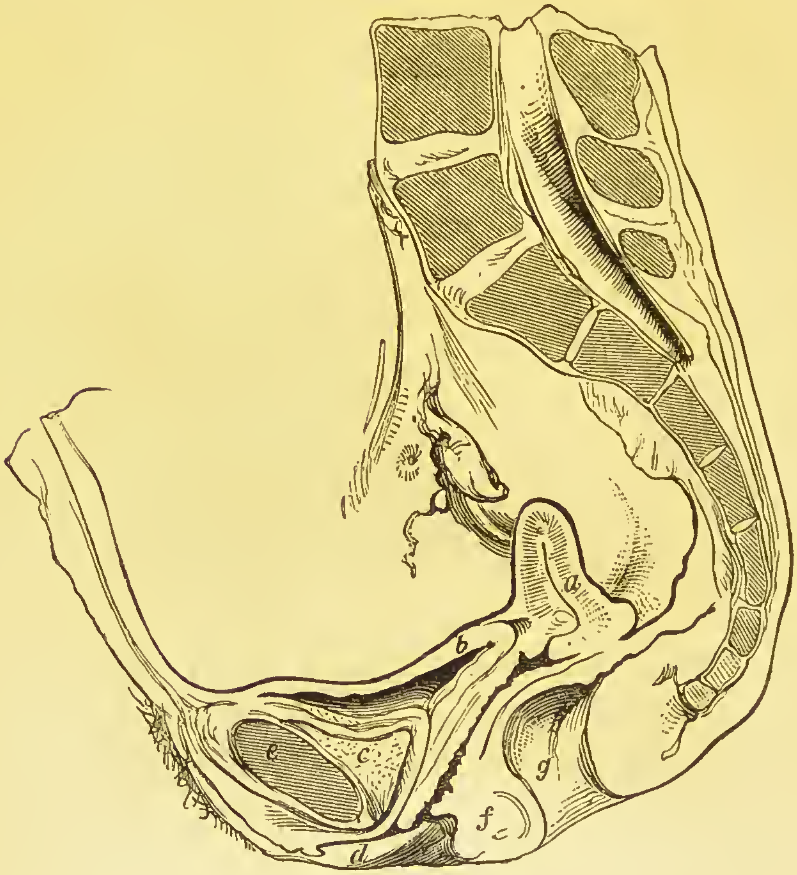


FIG. 54.

Mesial section through female pelvis, to show the form of the bladder in its empty condition.—*From* HART'S *article upon* "The Female Bladder."

(*a*) Uterus.
(*b*) Bladder (empty).
(c) Triangular interval usually found between pubis and bladder filled with fatty areolar tissue.
(*d*) Vaginal orifice.
(*e*) Symphysis.
(*f*) The perineum of the accoucheur.
(*g*) Rectum.

usually becomes flattened from above downwards, so as to obliterate in a great measure its vertical diameter. Taken in conjunction with the urethra, it presents, when seen in a mesial section, an outline something like the letter Y. The vertical limb of the letter represents the urethra (Fig. 54).

Ureters.—The pelvic portions of the ureters are longer in the female than in the male. They cross the internal iliac artery, and then extend forwards, one upon each side of the neck of the uterus, to the base of the bladder.

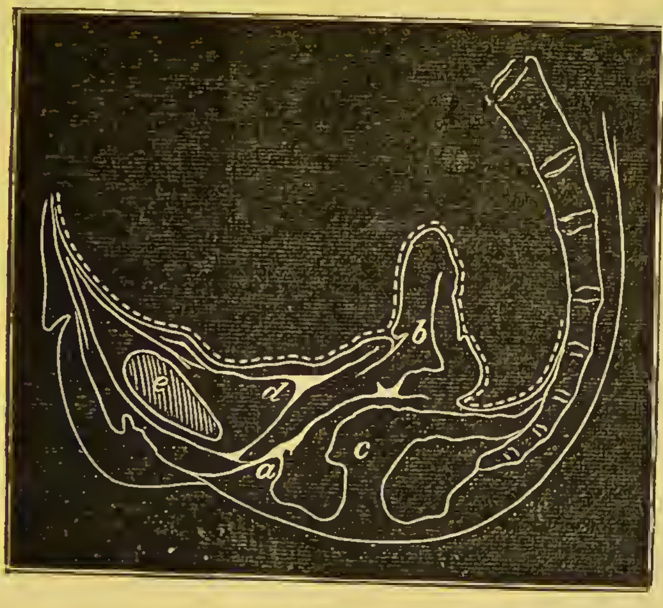


FIG. 55.

The preceding figure in a diagrammatic form to show the relation of the peritoneum, which is represented by a dotted line.

(*a*) Vagina.
(*b*) Uterus.
(*c*) Rectum.
(*d*) Bladder (empty).
(*e*) Symphysis.

Urethra.—A description of the female urethra will be found in connection with the perineum at p. 48.

The Uterus.—The uterus is the organ into which the ovum is received, and in which it is retained until the fœtus is fully developed. It is placed in the interval between the rectum and the bladder below the general mass of the small intestine, and above the vagina. *In shape*, it is pyriform or flask-shaped, flattened from before backwards. *In length*, it is about three inches; *in breadth*, at the broadest point, two inches; and *in thickness*, nearly an inch. The broader upper end of the uterus is directed upwards and forwards, whilst its narrow lower end looks downwards and backwards, and forms with the vagina an obtuse angle, which is open towards the pubis. The long axis of the organ may be said to correspond with that of the pelvic inlet.

It is customary to describe the uterus as being composed of three parts—viz., a fundus, a body, and a neck or cervix.

The *fundus* is the rounded upper end. The Fallopian tube enters the organ on each side at its upper angle, and a line drawn transversely between these is arbitrarily fixed upon as the limit between the fundus and the body of the uterus.

The *body* diminishes in breadth as it proceeds downwards towards the neck. In front and behind it is smooth and convex, the convexity of the posterior surface, however, being more marked than that of the anterior surface. Upon each side it is joined immediately below the entrance of the Fallopian tube, in front by the *round ligament*, and behind by the *ligament of the ovary*. Inferiorly, the body of the uterus is marked off from the neck by a slight constriction, which is very apparent in the infant, but which becomes less distinct as puberty approaches, and usually disappears altogether after parturition.

The *neck* or *cervix*, about an inch in length, is narrower than the body, and more uniformly rounded. It projects into the upper end of the vagina, the walls of which are attached to the uterus around it. To obtain a satisfactory view of the cervix uteri, it is necessary to slit up the vagina along its lateral aspect and to remove the stuffing. The posterior wall of the vagina will then be seen to ascend to a higher level upon the cervix than the anterior wall; or, in other words, the anterior wall of the vagina will be observed to be considerably shorter than the posterior wall. On the lower extremity of the cervix there is an aperture called the *os uteri externum*. In the virgin this opening is circular, but in females that have borne children it is usually transverse and somewhat irregular in outline. It is bounded by two full rounded lips. Comparing these it will be noticed that the anterior lip is the thicker of the two, whilst the posterior is the longer. Although the anterior lip is the shorter it should be noted that, on account of the oblique position of the uterus, it is placed at a lower level in the vagina. The greater length of the posterior lip is due to the wall of the vagina passing higher up on that aspect of the uterus.

The *relations* of the uterus should next be studied. *Posteriorly*, it is invested completely by peritoneum, and is separated from the rectum by the recto-vaginal cul-de-sac, and any coils of small intestine which this may chance to contain. *Anteriorly*, it is covered in its upper three-fourths by peritoneum, below which it is in apposition with the base of the bladder.

Vagina.—The vagina is the passage which leads from the uterus to the vulva. In length it is about four and a-half or five inches, and it describes a gentle curve from above downwards and forwards, so that its long axis corresponds with that of the pelvic outlet. Superiorly, its walls are firmly attached to the sub-

FIG. 56.

Diagram to show the close approximation of the anterior and posterior walls of the vagina. The vaginal tube is represented in mesial section.—*From* HART.

(*a*) The perineum of the accoucheur.
(*b*) Urethra.
(*c*) Vagina.
(*e*) Anterior lip of cervix uteri.
(*f*) Posterior lip of cervix uteri.

stance of the uterus, upon which it ascends to a higher level behind than in front; on account of this, the cervix uteri has the appearance of piercing its anterior wall. The vagina is wider in the middle than at either end, and the anterior and posterior walls are closely applied to each other. In section, therefore, it appears simply as a transverse or longitudinal slit according to the direction in which it is divided (Figs. 52 and 56).

Posteriorly, the upper end of the vagina is in relation to the bottom of the recto-vaginal pouch of peritoneum. Below this it is in apposition with the second part of the rectum, the recto-vaginal layer of pelvic fascia intervening. Still lower down, it is separated from the third part of the rectum by an angular interval. *Anteriorly*, it is related to the base of the bladder and to the urethra—indeed, the latter may almost be said to be embedded in its wall. *Upon each side* of the vagina, the levator ani muscle descends and gives it support, whilst its lower end is embraced by the sphincter vaginæ.

Ovaries.—The ovaries are two small solid bodies contained within the posterior secondary folds of the the broad ligaments. Each ovary is oval or oblong in figure, slightly compressed from above downwards, and having a size little greater than that of a pigeon's egg. The superior and inferior surfaces, with the posterior border, are free. The *inner end* is joined to the uterus by a round cord-like structure called the *ligament of the ovary*, whilst the *outer end* is attached to the wide mouth of the Fallopian tube by one of the fimbriæ. The *anterior border* is thinner and straighter than the posterior border, and is frequently termed the hilus, because the vessels and nerves enter and leave the organ along its whole length.

Before puberty the surface of the ovary is smooth and uniform. After this period, however, it becomes scarred and puckered from the breaches which are made by the escape of the ova from the Graafian follicles.

Parovarium, or the Organ of Rosenmüller.—This structure is of interest because it is the representative of the epididymis in the male. It is somewhat triangular in form, and will be discovered by an attentive examination of that portion of the broad ligament of the uterus which stretches between the ovary and the Fallopian tube. Its apex is directed towards the former, and its base towards the latter; but it is free between the two layers of the ligament, and not connected with either. In structure it will be seen to consist of a number of tubules which radiate from the apex of the body and are joined together by a longitudinal tube (the homologue of the duct of Gærtner in the cow, &c.), which extends along its base.

The Fallopian Tubes or Oviducts.—These are two tubes which have as their function the conveyance of the ova or eggs from the ovary to the uterus. Each duct is about three or four inches long, and is contained within the superior free border of the broad ligament of the uterus. Its inner extremity pierces the uterus at its superior angle, whilst its outer end is situated about an inch beyond the ovary and opens into the peritoneal cavity by a constricted orifice, surrounded by numbers of fringe-like processes, called *fimbriæ*. By one of these fimbriæ it has already been observed to be attached to the outer end of the ovary. The calibre of the Fallopian tube is by no means uniform. It is often compared in this respect to a trumpet. Thus it is narrow and cord-like towards the uterus, but, proceeding outwards, it becomes expanded and flexuous.

Round Ligaments of the Uterus.—The round ligaments are two cord-like bands which are attached to the body of the uterus immediately in front and a little below the entrance of the Fallopian tube—one on each side. From this each ligament is directed outwards and forwards between the layers of the broad ligament and in front of the oviduct, to the internal abdominal ring. It has already been examined within the inguinal canal. In the young subject the peritoneum is usually prolonged along with it into this canal in the form of a tubular process termed the "*Canal of Nuck.*" Later on this becomes obliterated.

Pelvic Blood-vessels.

The manner in which the blood-vessels of the pelvis should be dissected is described at p. 257. In the female, however, three additional arteries will be found, viz.—

(1.) The uterine, } branches of the internal iliac.
(2.) The vaginal, }
(3.) The ovarian, from the abdominal aorta.

The Uterine Artery springs from the anterior division of the internal iliac artery, and proceeds downwards and inwards to the neck of the uterus. At this point it gives several small branches to the vagina and bladder, and, changing its direction, extends upwards in a tortuous manner along the lateral border of the uterus and between the two layers of the broad ligament. Reaching the fundus, it sends several twigs outwards into the broad ligament; of these, one accompanies the round ligament, another goes with the Fallopian tube, and several proceed to the ovary, and anastomose with twigs from the ovarian artery. Whilst in contact with the lateral border of the uterus, the uterine artery gives numerous branches to this organ, and these, from their taking a somewhat spiral course in its substance, are frequently spoken of as the "curling arteries of the uterus."

The Vaginal Artery also springs from the anterior division of the internal iliac, but it is not unusual for it to arise in common with the uterine artery, or the middle hæmorrhoidal. It is distributed to the vagina, and sends twigs to the adjacent rectum and bladder.

The Ovarian Artery.—The course which this vessel takes within the abdomen proper is described at p. 208. When it arrives at the pelvis, it insinuates itself between the two layers of the broad ligament of the uterus, and becoming highly tortuous, runs towards the anterior border of the ovary. Here, it breaks up into numerous branches, which sink into the substance of this organ. In addition to these it sends a twig to the Fallopian tube, another to the round ligament, and several towards the uterus, which anastomose with branches of the uterine artery.

The other arteries of the female pelvis are identical with those of the male, and therefore it is needless to repeat the description which will be found at p. 258.

Veins of the Pelvis.—Very few facts require to be added to those which are given regarding the veins of the male pelvis (p. 264). Of course there is no prostatic plexus of veins in the female, and therefore the *dorsal vein of the clitoris* joins the vesical plexus.

Both the vagina and uterus are surrounded by large tortuous veins, constituting a *vaginal* and a *uterine plexus*. From the former, the blood is drained away into the internal iliac vein, whilst from the uterine plexus it is chiefly carried away by the ovarian veins.

Pelvic Diaphragm.

This is described at p. 265. The dissector should note, however, that the anterior fibres of the *levator ani* muscle, which in the male are connected with the prostate, pass downwards upon the lateral aspect of the vagina and give it support (Fig. 52).

The *pelvic floor* of the accoucheur is somewhat different from that of the anatomist. To the former the uterus is the all-important organ of the pelvic cavity, and the other contents are of importance merely in so far as they influence it. The pelvic floor, therefore, has recently been described (Hart) as consisting of an anterior triangular portion, made up of the bladder and anterior vaginal wall, and a posterior sacral portion. During parturition, the anterior or pubic part is lifted upwards and the posterior sacral part is pushed downwards to allow the escape of the child. This has been compared by Hart to the action of a double folding door, when one division is pulled in one direction and the other pushed in an opposite direction.

Nerves of the Pelvis.

Very little requires to be added to what has already been said regarding the nerves of the male pelvis (p. 267). There is no *prostatic plexus ;* but a *vaginal plexus*, an *ovarian plexus*, and numerous *uterine nerves* are present in addition to those mentioned in the male.

The *uterine nerves* proceed from the pelvic plexus, before it is joined by the twigs from the third and fourth sacral nerves. They ascend between the two layers of the lateral ligament along with the uterine artery, but in their distribution to the uterus, they do not rigorously accompany the branches of this vessel.

The *vaginal plexus* is an offset from the pelvic plexus, and the nerves which compose it are not plexiform in their arrangement.

The *ovarian plexus* is derived from the aortic and renal plexuses, and accompanying the artery of the same name, is distributed to the ovary.

Coccygeal Body.—*Vide* p. 274.

Removal of Viscera.—The viscera should now be removed from the pelvic cavity. Begin by cutting the various nerves and vessels which enter them, the levator ani and the anterior true ligaments of the bladder. Then carefully divide the parts which hold the urethra and vagina to the arch of the pubis. Lastly, separate the rectum from its connections with the sacrum and coccyx.

The *obturator internus* and *pyriformis muscles* should now be studied. They are described at page 274.

The viscera should next be separated from each other, but the vagina must be left attached to the uterus, and the urethra to the bladder.

Coats of the Rectum.—The coats of this portion of the intestinal canal are identical in both sexes. The student may therefore refer to p. 275, where the walls of the male rectum are described.

Bladder.—All further particulars regarding the bladder may be obtained by turning back to p. 277. In slitting open this viscus the urethra should be laid open along its upper surface at the same time.

Urethra.—The external meatus is the narrowest part of this tube. As it is traced upwards, it will be seen to expand before joining the neck of the bladder, and close to the meatus its floor will be noticed to be somewhat depressed so as to form a slight hollow.

Interior of the Uterus.—The uterus with its appendages should now be laid upon its posterior surface on a block, and opened by a longitudinal mesial incision, extending from the fundus to os uteri externum. A slight cut should also be made outwards from the upper end of this incision towards the entrance of each Fallopian tube. The cut edges may now be pared so as to extend the view into the interior of the uterus.

By this dissection the student will observe—(1.) That the walls of the uterus consist of three marked layers—viz., a peritoneal, a muscular, and a mucous. (2.) That the uterine wall differs in thickness at different points. Thus it is thickest opposite the middle of the body, and again at the fundus it is thicker in the mesial plane than it is nearer the entrance of the Fallopian tubes.

The cavity in the interior of the uterus is much smaller than would be naturally expected from the size of the organ. It is subdivided arbitrarily into an *upper part*, which occupies the body, and a *lower* or *cervical part*, which occupies the cervix.

The *upper portion* is the larger of the two, and is triangular in form—the sides of the triangle being incurved, and its base directed upwards. At the two extremities of the base are the constricted openings of the Fallopian tubes.

The *lower cervical portion* is fusiform or spindle-shaped in form, being also slightly compressed from before backwards. Above, it is somewhat constricted, and at the junction of the body with the cervix of the uterus it becomes continuous with the upper triangular part of the cavity. This narrow opening is termed the *os uteri internum*. Below, the cavity of the uterus opens into the vagina at the os uteri externum.

Mucous Membrane of the Uterus.—The dissector will not fail to note a striking difference between the mucous lining of the uterus in the triangular cavity of the body and in the fusiform cavity of the cervix. In the former it is smooth and even, and tightly bound down to the subjacent muscular tissue. In the cervix it presents a remarkable disposition, which, from its appearance, has been termed the *arbor vitæ*. This consists of a series of prominent folds or rugæ arranged in a definite manner. Thus there is an anterior and posterior median fold or raphe, and from this secondary folds branch off and pass obliquely upwards and outwards. The arbor vitæ is more marked upon the anterior than upon the posterior wall.

The student should look between the folds of the arbor vitæ for *ovula Nabothi*. These are minute vesicles filled with a yellowish liquid. At one time they were thought to be ova, whereas they are merely follicles distended with fluid.

Fallopian Tubes.—The Fallopian tubes should be opened towards their expanded ovarian extremities, and a probe introduced. It will be found, however, that the canal is too narrow to admit this into the uterus; indeed, the uterine aperture of the tube will barely allow the passage of a bristle. The ovarian orifice of the tube is also much constricted. To obtain a proper idea of the fimbriæ which surround this opening, the tube should be immersed in water, when the fringes will float out and separate from each other.

Mucous Membrane of the Vagina.—The mucous lining of the vagina should now be examined. It will be observed to present special peculiarities. Two well-marked median and longitudinal folds extend upwards, one upon the anterior and the other upon the posterior wall. These are termed the *columnæ rugarum*, and from each side they send off numerous transverse denticulated rugæ, which are arranged so that those on the anterior wall fit in between those on the posterior wall. These folds are best marked near the vaginal orifice, and are absent at the upper end of the canal.

Pelvic Articulations.

These are described at p. 287. It is an interesting fact to know that in the later months of pregnancy the soft tissues of the various pelvic joints become softened, thickened, and infiltrated. The pelvic bones are thus partially separated from each other, and the width of the pelvic circle is increased.*

* *Vide* Dr. Matthews Duncan in "Researches in Obstetrics."

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